MARICOPA ASSOCIATION of GOVERNMENTS

MAG Regional Concept of Transportation Operations

Technical Memorandum No. 5/6

- Necessary Institutional Arrangements and Resources Required for Implementation

Prepared by:

Kimley-Horn and Associates, Inc.
In association with

PB Farradyne, Inc.
TranSmart Technologies, Inc.

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1. INTRODUCTION

The purpose of the Regional Concept of Transportation Operations is to foster a higher level of integration and coordination among agencies responsible for transportation operations in the Maricopa Association of Governments (MAG) region. This Technical Memorandum presents the institutional arrangements and resources required for implementation of the concept of operations.

1.1 Memorandum Contents

Specifically, this memo contains:

- A review of existing institutional arrangements for Intelligent Transportation Systems Operations in the MAG Region;
- Identification of functions of local and regional agencies to facilitate the implementation of Regional Concept of Transportation Operations;
- Responsibilities of local and regional agencies;
- Enhancements to existing institutional relationships required to implement the concept of operations;
- Staffing requirements for local and regional agencies for the operations and management of ITS;
- Sample budgets for management and operations of ITS; and
- Alternative staffing approaches for management and operations of ITS.

1.2 Review of Vision and Mission Statements

The stakeholders in the MAG region envision a safe, reliable, efficient, and seamless surface transportation system. This will be achieved by:

- Identifying and securing funding sources;
- Actively managing and operating multimodal transportation systems;
- A high degree of information sharing, integration, and coordination;
- Defining and agreeing to appropriate roles and responsibilities;
- Establishing and implementing applicable policies, procedures, and practices;
- Dedicating and training human resources; and
- Continuous improvement of performance against customer driven indicators.

1.3 Review of Concept of Transportation Operations Development

The MAG Regional Concept of Transportation Operations is the culmination of a series of documents that have been developed over an eight-month period. The development of the concept of transportation operations is shown graphically in **Figure 1-1**.

Tech Memo No. 1 provided an inventory of existing policies and practices for transportation operations in the MAG Region. Tech Memo No. 1 helped to identify areas for potential improvement in transportation operations. National best practices relating to these areas were subsequently explored in Tech Memo No. 2.

Tech Memo No. 3 presented the 3-year and 5-year goals for transportation operations in the region. Performance measures for each of the goals also were presented. Tech Memo No. 4 identified policies and practices that will be needed in order to achieve the 3-year and 5-year goals.

Following completion of Tech Memo No. 4, two workshops were held. The purpose of these workshops was to receive stakeholder consensus on specific functions and responsibilities of agencies in implementing the concept of operations.

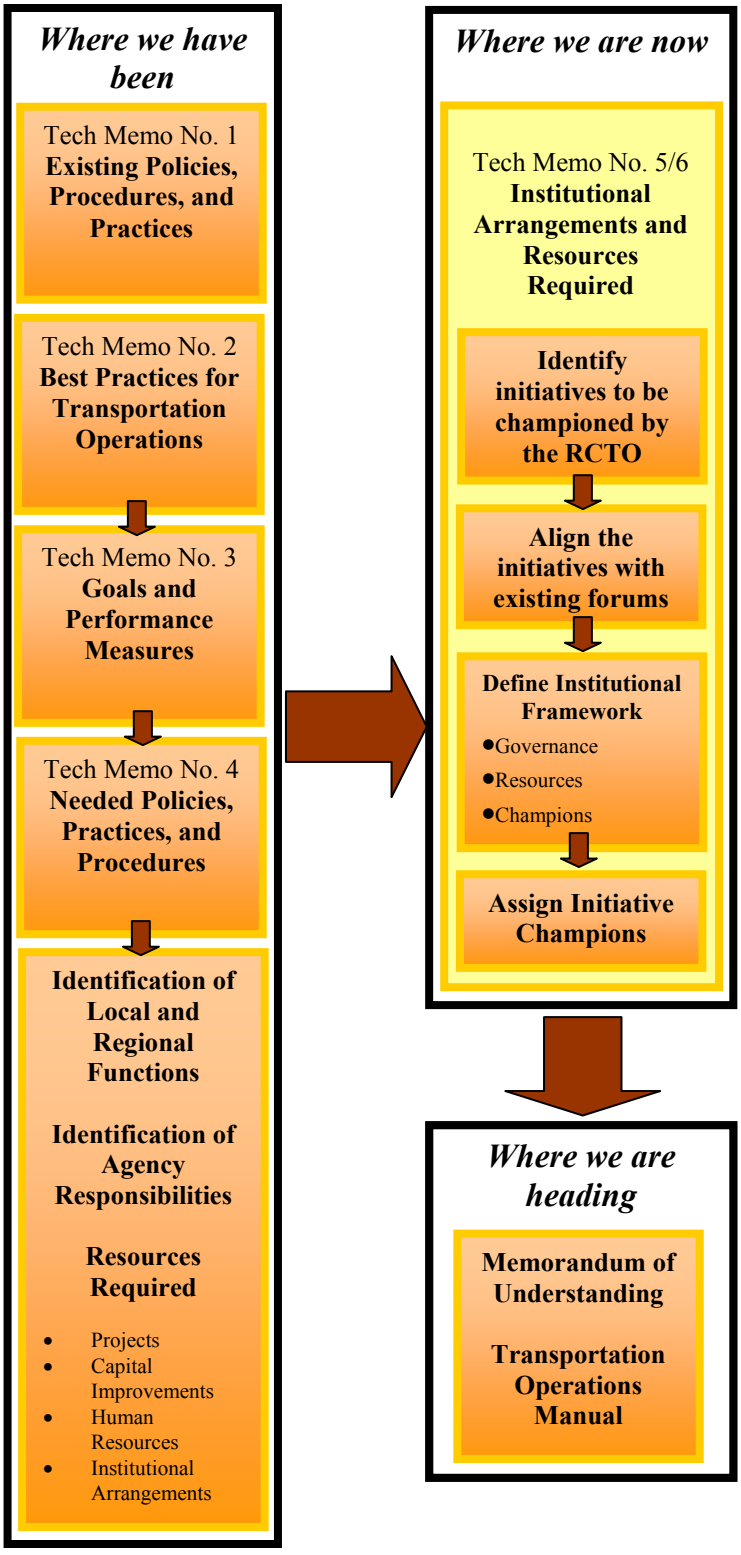

Figure 1-1 – Development of the Regional Concept of Transportation Operations

2. FUNCTIONS OF LOCAL AND REGIONAL AGENCIES TO IMPLEMENT THE CONCEPT OF OPERATIONS

In order to refine responsibilities for implementation of the concept of transportation operations, functions needed to achieve the 3-year and 5-year goals (see Tech Memo No 3: Goals and Performance Measures) were identified. The functions are shown in Table 3-1. The functions are categorized as local functions, local/regional functions, and regional functions.

Figure 2-1 illustrates the relationship between the local functions, local/regional functions, and regional functions. As can be seen from **Figure 2-1**, the local functions provide the foundation for improved transportation operations in the MAG Region.

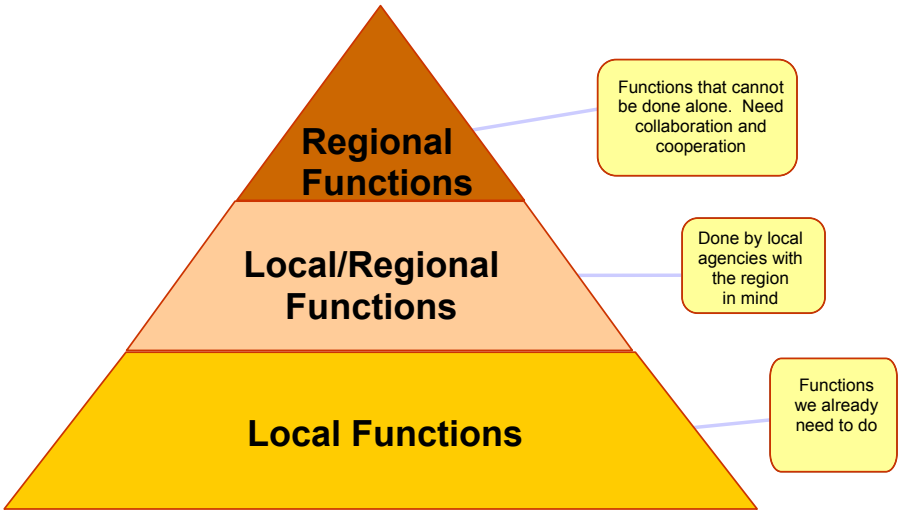

Figure 2-1 – Relationship between Local and Regional Functions

2.1 Local Functions

Local functions are those that are the responsibility of an individual agency. They can be viewed as functions pertaining to transportation operations that an agency would be doing anyway even if they had no neighboring cities. An example of a local function is routine traffic signal systems management. In order to manage and maintain the traffic signal system, an agency does not need to coordinate with agencies outside of the jurisdictional boundaries. Hence, the management of the traffic signal system is strictly a local function. Some local functions that have been identified include:

- Traffic signal systems operations, including the optimization of with-in city intersections;
- Traffic signal systems maintenance and repair, including field devices and central system;
- Transit system management; and
- Incident management.

2.2 Local/Regional Functions

Local/Regional functions are those that can be carried out by the local agency (do not require interagency communication) but would benefit the city and the region if done with a regional perspective. These are functions carried out by the *local* agency that provide *regional* benefits. Local functions that provide regional benefits include:

- Incident management;
- Freeway system ramp metering operations and maintenance;
- Traffic signal operations of cross-border traffic signals and regional arterials;
- Maintenance of central control systems, including regional systems housed in the Arizona Department of Transportation Traffic Operations Center (TOC);
- Provide work zone and incident and transit information to Highway Condition Reporting System (HCRS) and/or 511;
- Notifying other agencies of incidents/work zones that may significantly impact traffic;
- Develop agency-specific incident management practices that will result in reduced incident clearance times;
- Plan, deploy, operate, maintain and evaluate a Transit Signal Priority system;
- Develop regionally accepted standard for Emergency Vehicle Pre-emption System (EVPS);
- Develop practices for collecting information from arterial detectors (also in Regional Functions);
- Facilitate agreements between agencies for the extraction of Computer Aided Dispatch (CAD) information to travel information services, Traffic Management Centers (TMCs), and ADOT TOC; and
- Facilitate practices for transit operators to notify TCC of incidents, congestion, etc.

2.3 Regional Functions

Regional functions are those functions that are performed for the regional and local benefit and cannot be performed without regional communication and collaboration between agencies (TMCs, dispatch centers, etc.). The identified regional functions are:

- Establish center-to-center communications between agencies;
- Facilitate inter-agency collaboration for signal timing optimization;
- Facilitate/provide after-hours/extended hours monitoring of traffic signal systems;
- Develop regional pre-set signal timing structure and criteria for signal timing plan changes during incidents;
- Plan, deploy, operate, maintain freeway-arterial corridor operations projects;
- Maintain regionally significant communications (fiber-optic, other) lines;
- Develop, implement, and maintain Arterial Incident Management program;
- Develop and maintain cost sharing agreements such as pooled funding, Joint Project Agreements (JPAs), manage multi-jurisdictional resources (shared human resources, equipment, etc.);
- Develop regional data archiving system;
- Develop practices for the marketing of travel information services;
- Develop practices for collecting information from arterial detectors;

- Establish practices and procedures to notify cities/agencies and agencies of incidents that may require alteration of signal timing;
- Participate in incident debriefing sessions after large incidents with representatives of public safety and emergency management;
- Develop and maintain interagency incident response plan;
- Develop and maintain a comprehensive personnel and logistics resource list;
- Integrate Freeway Service Patrol (FSP) and ADOT ALERT Operations;
- Improve public education of quick clearance laws;
- Facilitate development of practices for on-scene coordination and communication;
- Facilitate improvement of best practices for placement of emergency vehicles at incident scenes; and
- Improve pre-qualified list of towing and recovery vehicles.

2.3 Stakeholder Perception of Local, Local/Regional, and Regional Functions

At the March 5, 2003 Stakeholder Group meeting, the above listed local, local/regional, and regional functions were presented and agreed. The group was asked their opinion on where we are today, where we want to be in 3 years, and where we want to be in 5 years as a region in terms of executing the local, local/regional, and regional functions. The group rated each function category on a scale of 1 to 10.

The average results of the informal survey are shown in **Table 2-1**.

Table 2-1 – Stakeholder Perception in Executing Local, Local/Regional, and Regional Functions

	Where we are today (2003)	Where we want to be in 3-years time (2006)	Where we want to be in 5-years time (2009)
Local Functions	6.6	7.9	9.3
Local/Regional Functions	4.5	6.7	8.4
Regional Functions	3.7	6.2	8.0

As seen in **Table 2-1**, the group perceived that stakeholders in the region currently execute local functions fairly well (6.6 out of 10), while the region does not currently perform well in executing regional functions (3.7 out of 10). The group generally desires to see dramatic improvement in 5-years especially in the area of regional functions (8 out of 10). The results are shown graphically in **Figure 2-2**.

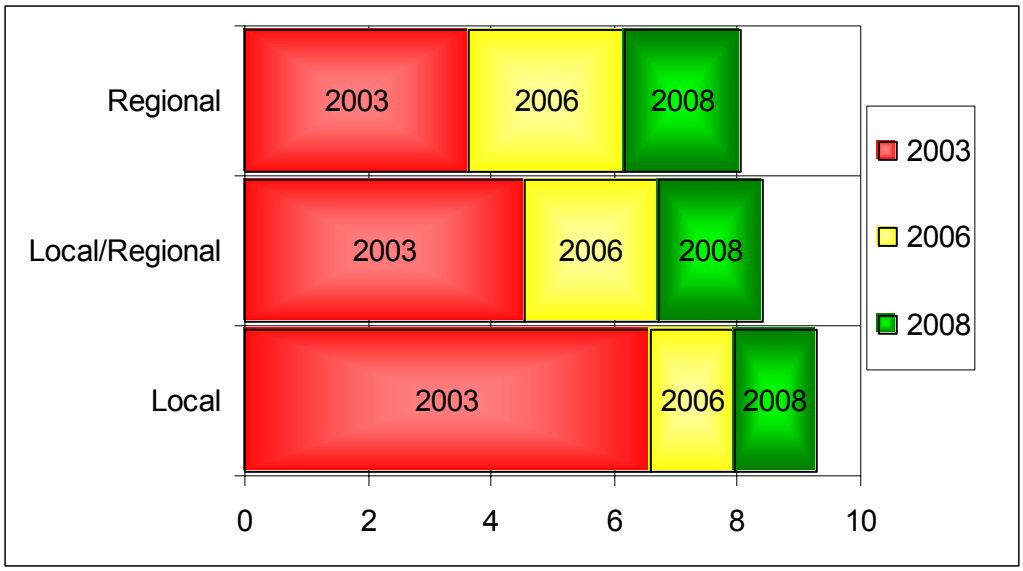

Figure 2-2 – Stakeholder Perception in how well they are and would like to perform Local, Local/Regional, and Regional Functions

3. RESOURCES REQUIRED TO IMPLEMENT THE CONCEPT OF OPERATIONS

Successful implementation of the concept of operations depends on the availability and commitment of adequate resources. Required resources may include additional projects, staff, capital improvements, and additional institutional relationships. The purpose of this section is to outline the resources required to implement each function identified in section 2.

Table 3-1 displays the functions identified in section 2 sorted by operational category. For ease of reference, each function is assigned a function number.

Tables 3-2 through **3-35** are individual *Function Summary Sheets*. Each function identified in section 3 is shown on an individual *Function Summary Sheet*. Each sheet contains information pertaining to:

- Activities associated with the function;
- Specific agency roles and responsibilities to plan, implement, operate and maintain activities necessary to implement the function;
- Resources that will be required to implement the function, including specific projects, capital improvements, human resources, and institutional arrangements;
- Estimated costs to plan, implement, operate, and maintain activities and projects associated with the function; and
- The status of the function as it pertains to consensus, funding, and implementation.

The *Function Summary Sheets* present each function in a concise format. A transportation manager can utilize the *Function Summary Sheet* to the role that his/her agency plays in the Regional Concept of Transportation Operations. The transportation manager can help his/her colleagues understand the activities that the agency has agreed to do as part of the Regional Concept of Transportation Operations. A transportation manager can select the *Function*

Summary Sheets pertinent to his/her agency and distribute them to TOC/TMC operators, traffic engineers, maintenance personnel, public safety personnel, and other appropriate individuals as applicable.

Table 3-1 – Local and Local/Regional Functions by Category

Category	Function Type	Function Description
Freeway Mobility	Local/Regional	1. Freeway system ramp metering operations and maintenance
Arterial Mobility	Local	2. Traffic signal systems operations, including the optimization of with-in city intersections
	Local/Regional	3. Traffic signal operations of cross-border traffic signals and regional arterials
Freeway Incident Management	Local/Regional	4. Improve agency-specific incident management practices that will result in reduced incident clearance times
	Regional	5. Participate in incident debriefing sessions after large incidents with representatives of public safety and emergency management
	Regional	6. Develop and an maintain interagency incident response plan
	Regional	7. Develop and maintain a comprehensive personnel and logistics resource list
	Regional	8. Integrate Freeway Service Patrol (FSP) and ADOT ALERT Team Operations
	Regional	9. Improve pre-qualified list of towing and recovery vehicles
	Regional	10. Improve public education of quick clearance laws
	Local/Regional	11. Facilitate agreements between agencies for the extraction of CAD information, where available, to travel information services and ADOT TOC
	Regional	12. Facilitate improvement of practices for on-scene communication
	Regional	13. Facilitate improvement of practices for placement of emergency vehicles at incident scenes
Freeway-Arterial Interface	Regional	14. Plan, deploy, operate, and maintain a research freeway-arterial corridor operations pilot project
Arterial Incident Management	Regional	15. Develop, implement, and maintain Arterial Incident Management program, based on results of feasibility study and pilot project
	Local/Regional	16. Facilitate practices for transit operators to notify transit control center (TCC) of incidents, congestion, etc.
	Local/Regional	17. Facilitate agreements between agencies for extraction of CAD information, where available, for local traffic management centers
	Regional	18. Develop regional pre-set signal timing structure and criteria for signal timing plan changes during incidents
	Local/Regional	19. Develop regionally accepted standard for emergency vehicle signal preemption

Table 3-1 – Local and Local/Regional Functions by Category (continued)

Category	Function Type	Function Description
Transit Mobility	Local/ Regional	20. Plan, deploy, operate, maintain and evaluate a transit signal priority pilot project
Maintenance and Reliability	Local	21. Traffic signal systems maintenance and repair, including field devices and central system
	Local/Regional	22. Maintenance of central control systems, including regional systems housed in the ADOT TOC
	Regional	23. Maintain regionally significant communications (fiber-optic, other) lines
	Regional	24. Develop and maintain cost sharing agreements such as pooled funding, JPAs, manage multi-jurisdictional resources (shared human resources, equipment, etc.)
Multi-agency Coordination	Regional	25. Establish center-to-center communications between agencies
	Regional	26. Develop and implement a regional data archiving system
	Regional	27. Develop practices for after-hours/extended hours monitoring of local TMC systems devices
	Local/Regional	28. Facilitate practices to notify other agencies of incidents/work zones that may significantly impact traffic
	Local/Regional	29. Make available work zone and incident and transit information to HCRS and/or 511
Traveler Information	Local/Regional	30. Integrate transit information with travel information services (e.g. Provide AVL data to 511)
	Regional	31. Develop practices for collecting information from arterial detectors
	Local/Regional	32. Post travel information/messages on freeway and arterial VMS and on internet
	Regional	33. Market travel information services

Table 3-2 – Function No. 1 Summary Sheet (ramp metering operations)

Function No. 1 Freeway Mobility			
Freeway system ramp metering operations and maintenance • Develop traffic responsive ramp metering operational strategies • Operate and maintain responsive ramp metering system			
Roles and Responsibilities			
Planning	**Implementation**	**Operations**	**Maintenance**
• **ADOT Traffic Operations Center**[1] • Regional Coordination	• **ADOT Traffic Operations Center**	• **ADOT Traffic Operations Center**	• **ADOT Traffic Operations Center**
Resources Required and Estimated Costs			
Projects	**Capital Improvements**	**Human Resources/Staff**	**Institutional Arrangements**
Traffic Responsive Ramp Metering Integration Research Project - Likely funded by ATRC, estimated completion in 2006.	Traffic responsive ramp-metering utilizes the same field components as pre-timed metering, but requires additional logic. Incremental cost is in the 10-15 percent range (*Traffic Control System Operations, Installation, Management and Maintenance, ITE, 2000*)	May require additional technical expertise and training of ADOT staff. Initial operations may require a significant amount of staff resources until ADOT becomes comfortable with the system and technicalities are resolved. Once system is running, additional required staff resources is minimal.	
To be determined	To Be Determined	To Be Determined	No costs identified
Additional Information: Operation of traffic-responsive ramp metering is similar to that of a pre-timed metering system; except for in traffic-responsive ramp metering the metering rate selection is based on real-time measurements of traffic variables that describe traffic flow conditions on the mainline. The primary advantage of traffic-responsive ramp metering is its automatic adaptation to changes in traffic flow, thus helping to minimize adverse affects caused by short-term variations in traffic demand and reduction in capacity caused by incidents (*Traffic Control System Operations, Installation, Management and Maintenance, ITE, 2000*). Further evaluation is needed to determine status of FMS software. Costs for implementation of traffic responsive ramp metering will be determined after study.			
Status			
Further Consultation Required ___	Agreed Upon ___	Funded ___	Implemented ___

[1] Where applicable, lead agency appears in **bold** text. If multiple agencies appear in single column, and no single agency appears in **bold,** then all agencies share equal role

Table 3-3 – Function No. 2 Summary Sheet (intra-city signal systems operations)

Function No. 2			Arterial Mobility
Traffic signal systems operations, including the optimization of within city intersections • The optimization of within city intersections • Review and modification (if necessary) of signal timing on a regular basis			
Roles and Responsibilities			
Planning	**Implementation**	**Operations**	**Maintenance**
• **MAG** • LTMCs • Local Transportation Departments • Regional Coordination	• **LTMCs**	• **LTMCs**	• **LTMCs** • Local Transportation Departments
Resources Required and Estimated Costs			
Projects	**Capital Improvements**	**Human Resources/Staff**	**Institutional Arrangements**
Regional Traffic Engineering Collaboration Program (RTECP) 2300 traffic signals • Signal timing assessed once every 3 years • $1200 per signal per timing assessment Currently funded at $300,000 for two years	No capital resources will be required	*Project Manager* to oversee RTECP Individual(s) will be responsible for: • Presenting needs for prioritization • Managing consultant contracts (if applicable) • City staff will be required to review timing plans for signals within their jurisdiction	*Regional Traffic Engineering Collaboration Group* *MAG Committee* Process may be required to prioritize needs and distribute federal funds
$980,000 annually	No costs identified	1 FTE .25 FTE from City Staff	No costs identified
Additional Information: Costs for Regional Traffic Engineering Collaboration Program include all intersections. Costs will be less if program limited to signals on major arterials or smart corridors. Funding alternatives include: • Pooled City Funds • Inclusion of RTECP in regional transportation planning process (MAG TIP)			
Status			
Further Consultation Required ___	Agreed Upon ___	Funded ___	Implemented ___

Table 3-4 – Function No. 3 Summary Sheet (inter-city signal systems operations)

Function No. 3 Arterial Mobility			
Traffic signal operations of cross-border traffic signals and regional arterials • Facilitate inter-agency collaboration for signal timing optimization • Optimize signalized intersections • Identification of control section groups, maintain inventory of control groups • Modify control groups, when necessary • Ensure a common understanding of signal timing operating strategies between agencies • Communicate with adjacent agencies prior to making signal timing changes on corridors that cross jurisdictional boundaries			
Roles and Responsibilities			
Planning	**Implementation**	**Operations**	**Maintenance**
• **MAG** • LTMCs • Local Transportation Departments • Regional Coordination	• **LTMCs**	• **LTMCs**	• **LTMCs** • Local Transportation Departments
Resources Required and Estimated Costs			
Projects	**Capital Improvements**	**Human Resources/Staff**	**Institutional Arrangements**
This will be included in the *Regional Traffic Signal Optimization Program* 2300 traffic signals • Signal timing assessed once every 3 years • $1200 per signal per timing assessment	No capital resources will be required	*Project Manager* to oversee Regional Traffic Engineering Optimization Program Individual(s) will be responsible for: • Providing technical support/guidance • Managing consultant contracts (if applicable) City staff will be required to review timing plans for signals within their jurisdiction	Regional Traffic Engineering Optimization Program Group *MAG Committee* Process may be required to prioritize needs and distribute federal funds
Costs included with estimate on function 2	No costs identified	1 FTE .2 FTE from City Staff	No costs identified
Additional Information: Costs for Regional Traffic Signal Optimization Program include all intersections. Costs will be less if program limited to signals on major arterials or smart corridors. Funding alternatives include: • Pooled City Funds • Inclusion of Regional Traffic Signal Optimization Program in regional transportation planning process (MAG TIP)			
Status			
Further Consultation Required ___	Agreed Upon ___	Funded ___	Implemented ___

Table 3-5 – Function No. 4 Summary Sheet (incident management practices)

Function No. 4	Freeway Incident Management Arterial Incident Management		
Improve agency-specific incident management practices that will result in reduced incident clearance times • Engage stakeholders in processes to improve agency-specific incident management practices			
Roles and Responsibilities			
Planning	**Implementation**	**Operations**	**Maintenance**
• **DPS** • **Local Public Safety** • ADOT • Fire Departments • Regional Coordination	• **DPS** • **Local Public Safety** • ADOT • Fire Departments • Regional Coordination	• **DPS** • **Local Public Safety** • ADOT • Fire Departments	• **DPS** • **Local Public Safety** • ADOT • Fire Departments • Regional Coordination
Resources Required and Estimated Costs			
Projects	**Capital Improvements**	**Human Resources/Staff**	**Institutional Arrangements**
Incident Management (IM) Practices Analysis and Recommendations to facilitate the identification of specific areas in which incident management can be improved. Potential funding sources include FHWA Peer to Peer Program.	None identified	*Project Manager/Coordinator* for *Incident Management Practices Analysis and Recommendations* May be preferable that Project Manager be from public safety or emergency management agency Support staff will be needed to provide support to EMS Incident Mgmt. Groups Subsequent to project, training sessions may be required to implement improved practices	*EMS/Public Safety /Transportation Incident Management Policy Group* comprised of high-level representatives from DPS, Fire, Police, ADOT, City Transportation, and Towing *EMS/Public Safety /Transportation Incident Management Working Group* consisting of field operations personnel responsible for the technical development of IM practices
To be determined	No costs identified	.2 FTE .1 FTE (support staff)	No costs identified
Additional Information:			
Status			
Further Consultation Required ___	Agreed Upon ___	Funded ___	Implemented ___

Table 3-6 – Function No. 5 Summary Sheet (incident debriefing sessions)

Function No. 5	Freeway Incident Management Arterial Incident Management

Participate in incident debriefing sessions after large incidents with representatives of public safety and emergency management

- Conduct transportation-oriented incident debriefing session, if necessary

Roles and Responsibilities			
Planning	**Implementation**	**Operations**	**Maintenance**
• **DPS** • **Local Public Safety** • ADOT • LTMCs • Local Transportation Departments • Fire Departments • Regional Coordination	• **DPS** • **Local Public Safety** • ADOT • LTMCs • Local Transportation Departments • Fire Departments • Regional Coordination	• **DPS** • **Local Public Safety** • ADOT • LTMCs • Local Transportation Departments • Fire Departments • Regional Coordination	• **DPS** • **Local Public Safety** • ADOT • LTMCs • Local Transportation Departments • Fire Departments • Regional Coordination

Resources Required and Estimated Costs			
Projects	**Capital Improvements**	**Human Resources/Staff**	**Institutional Arrangements**
			EMS/Public Safety /Transportation Incident Management Policy Group comprised of high-level representatives from DPS, Fire, Police, ADOT, City Transportation, and Towing *EMS/Public Safety /Transportation Incident Management Working Group* consisting of field operations personnel responsible for the technical development of IM practices
	No costs identified	.2 FTE .1 FTE (Support Staff)	No costs identified

Additional Information:

Status			
Further Consultation Required ___	Agreed Upon ___	Funded ___	Implemented ___

Table 3-7 – Function No. 6 Summary Sheet (interagency incident response plan)

Function No. 6 Freeway Incident Management Arterial Incident Management			
Develop and maintain interagency incident response plan • Utilize shared VMS and CCTV during incidents • Alteration of traffic signals during incidents			
Roles and Responsibilities			
Planning	**Implementation**	**Operations**	**Maintenance**
• **ADOT Traffic Operations Center** • LTMCs • DPS • Local Public Safety • Fire Departments • Regional Coordination	• **ADOT Traffic Operations Center** • LTMCs • DPS • Local Public Safety • Fire Departments • Regional Coordination	• **ADOT Traffic Operations Center** • LTMCs • DPS • Local Public Safety • Fire Departments • Regional Coordination	• **ADOT Traffic Operations Center** • LTMCs • DPS • Local Public Safety • Fire Departments • Regional Coordination
Resources Required and Estimated Costs			
Projects	**Capital Improvements**	**Human Resources/Staff**	**Institutional Arrangements**
Standard Interagency Response Plan for Incident Collaboration within the MAG Region, including use of CCTV and VMS during incidents (listed previously)		The plan may require staffing of Local Traffic Management Centers and the ADOT Traffic Operations Center, commensurate with the size of the city and level of operations required.	*EMS/Public Safety /Transportation Incident Management Policy Group* comprised of high-level representatives from DPS, Fire, Police, ADOT, City Transportation, and Towing *EMS/Public Safety /Transportation Incident Management Working Group* consisting of field operations personnel responsible for the technical development of IM practices
To be determined	To be determined	To be determined	No costs identified
Additional Information: A standard set of interagency response action plans should be developed. The plans should be tailored for various incident scenarios and supported by shared data. The interagency response action plans may outline the practices associated with the use of VMS to inform motorists of incidents. The response plan also should list actions that local cities may implement, such as alterations to traffic signal timing plans.			
Status			
Further Consultation Required ___	Agreed Upon ___	Funded ___	Implemented ___

Table 3-8 – Function No. 7 Summary Sheet (personnel and logistics resource list)

Function No. 7	Freeway Incident Management Arterial Incident Management		
Develop and maintain a comprehensive personnel and logistics resource list			
Roles and Responsibilities			
Planning	**Implementation**	**Operations**	**Maintenance**
• **ADOT Traffic Operations Center** • LTMCs • Local Transportation Departments • DPS • Local Public Safety • Fire Departments • Regional Coordination	• **ADOT Traffic Operations Center** • LTMCs • Local Transportation Departments • DPS • Local Public Safety • Fire Departments	• **ADOT Traffic Operations Center** • LTMCs • Local Transportation Departments • DPS • Local Public Safety • Fire Departments	• **ADOT Traffic Operations Center** • LTMCs • Local Transportation Departments • DPS • Local Public Safety • Fire Departments • Regional Coordination
Resources Required and Estimated Costs			
Projects	**Capital Improvements**	**Human Resources/Staff**	**Institutional Arrangements**
Web Enabled Local and Regional Emergency Response Equipment and Personnel Inventory	None identified	*Project Manager/ Coordinator* Existing staff at dispatch centers, LTMCs and TOC, will utilize resource list. No additional staff is required	*Shared Maintenance and Resources Group* *Mutual Aid Agreements for Sharing of Resources*
To be determined	No costs identified	.1 FTE	No costs identified

Table 3-8 – Function No. 7 Summary Sheet (personnel and logistics resource list) (continued)

Function No. 7	Freeway Incident Management Arterial Incident Management

Develop and maintain a comprehensive personnel and logistics resource list

Additional Information:

A list of telephone contact numbers and catalog of available agency resources to facilitate coordinated inter-agency response. The list should identify basic contacts that respond to incidents within a geographic area, and a collection of comprehensive manuals or guides that will speed response and reduce incident duration by providing responders with a readily available data source.

The list should include geographic agency responsibility, radio frequencies, talk groups, primary and back-up phone numbers (pagers and 24-hour contacts), and FAX numbers, catalog of equipment material, and personnel with special skills. Once prepared, the guide should be distributed to all the response agencies and their dispatch centers. A regular update schedule should be established.

Examples of special services or equipment that may help resolve major freeway incidents or transportation emergencies include the following (Traffic Incident Management Handbook. Prepared for Federal Highway Administration, Office of Travel Management, November 2000)

- Highway construction, maintenance, and environmental contractors;
- Traffic control contractors, barrier wall suppliers;
- Trucking services, dumps, flatbeds, and roll-off dumpsters;
- Heavy equipment rental, end loaders, cranes, street sweepers;
- Truck tire and heavy equipment repair services;
- Temporary manpower;
- Livestock handling, transportation, and rendering services;
- Large-animal veterinarians;
- Sand, soda, lime, and absorbents; and
- Grain loading equipment.

Status			
Further Consultation Required ___	Agreed Upon ___	Funded ___	Implemented ___

Table 3-9 – Function No. 8 Summary Sheet (ALERT/FSP Operations)

Function No. 8 Freeway Incident Management			
Integrate Freeway Service Patrol (FSP) and ADOT ALERT Operations			
Roles and Responsibilities			
Planning	**Implementation**	**Operations**	**Maintenance**
• **ADOT Traffic Operations Center** • **ADOT** • DPS • MAG • FHWA	• **ADOT Traffic Operations Center** • **ADOT** • DPS	• **ADOT Traffic Operations Center** • **ADOT** • DPS	• **ADOT Traffic Operations Center** • **ADOT** • DPS
Resources Required and Estimated Costs			
Projects	**Capital Improvements**	**Human Resources/Staff**	**Institutional Arrangements**
DPS and ADOT ALERT are current projects that are already funded. No additional projects are required.	None identified	Staff for ADOT ALERT and FSP (Already funded)	None identified
$	No costs identified	Already funded	No costs identified
Additional Information: In the MAG region, the Freeway Service Patrol and ALERT play a crucial role in effective on-scene incident management; however, to be fully effective, they must be able to communicate and coordinate activities with other responding agencies, should have access to the proper radio frequencies, and be equipped with traffic control devices such as variable message signs. When properly equipped, the FSP and ALERT can provide invaluable assistance to emergency services personnel by managing traffic and relaying information to motorists (with portable VMS).			
Status			
Further Consultation Required ___	Agreed Upon ___	Funded ___	Implemented ___

Table 3-10 – Function No. 9 Summary Sheet (towing and recovery vehicles)

Function No. 9	Freeway Incident Management Arterial Incident Management		
Improve pre-qualified list of towing and recovery vehicles			
Roles and Responsibilities			
Planning	**Implementation**	**Operations**	**Maintenance**
• **DPS** • **Local Public Safety**	• **DPS** • **Local Public Safety**	• **DPS** • **Local Public Safety**	• **DPS** • **Local Public Safety**
Resources Required and Estimated Costs			
Projects	**Capital Improvements**	**Human Resources/Staff**	**Institutional Arrangements**
Responsive Towing Prequalification List *Review of and Recommended Changes to Arizona Liability Laws for the Towing of Vehicles from Arterials and Freeways Travel Lanes*	None identified	Current dispatch staff will utilize list. No additional human resources is required	None identified
To be determined	No costs identified	No staff/costs identified	No costs identified
Additional Information: In order to improve towing and recovery times, a listing of pre-qualified towing companies that are capable of providing responsive recovery should be established. Pre-qualification can improve responsiveness and reduce costs. Tow operators should be required to meet minimum requirements (e.g., number of vehicles in fleet, response rates and times, storage space, insurance and licensing). In addition, consideration could be given to additional requirements that improve responsiveness. An example requirement might be that all wreckers that respond to freeway incidents have push bumpers installed (Traffic Incident Management Handbook. Prepared for Federal Highway Administration, Office of Travel Management, November 2000).			
Status			
Further Consultation Required ___	Agreed Upon ___	Funded ___	Implemented ___

Table 3-11 – Function No. 10 Summary Sheet (quick clearance laws)

Function No. 10 Freeway Incident Management			
Improve public education of quick clearance laws			
Roles and Responsibilities			
Planning	**Implementation**	**Operations**	**Maintenance**
• **Governor's Office of Highway Safety** • DPS • ADOT	• **Governor's Office of Highway Safety**	• **Governor's Office of Highway Safety**	• **Governor's Office of Highway Safety** • DPS • ADOT
Resources Required and Estimated Costs			
Projects	**Capital Improvements**	**Human Resources/Staff**	**Institutional Arrangements**
Quick Clearance Laws Public Education Campaign • Include educational materials in registration notices • Deploy signs on freeways and arterials that inform motorists to remove their vehicles from travel lane in case of accident	None identified	*Project Manager/ Coordinator* Staff time of ADOT Public Relations, Motor Vehicle Division and DPS will be required	Education and Outreach Group
To be determined	No costs identified	.1 FTE	No costs identified
Additional Information: Arizona has enacted 'quick clearance laws', with the objective of minimizing the impact of traffic accidents on other traffic. The law states that drivers who are involved in an accident may promptly remove their vehicles from the roadway if they can be done so safely, and without further damage to the vehicle or the roadway. The law states that the state may remove vehicles from the travel way with the assistance of towing or recovery vehicles if the move will result in "improved safety or convenience of travel on the highway." The success of these laws is dependent on motorists knowing about the policy or regulation; therefore, a public education campaign should be organized to improve driver awareness of quick clearance laws.			
Status			
Further Consultation Required ___	Agreed Upon ___	Funded ___	Implemented ___

Table 3-12 – Function No. 11 Summary Sheet (extraction of CAD information to TOC/511)

Function No. 11 Freeway Incident Management			
Facilitate agreements between agencies for the extraction of CAD information, where available, to travel information services and ADOT TOC			
Roles and Responsibilities			
Planning	**Implementation**	**Operations**	**Maintenance**
• **ADOT Traffic Operations Center** • DPS • Regional Coordination	• **ADOT Traffic Operations Center** • DPS • Regional Coordination	• **ADOT Traffic Operations Center** • DPS	• **ADOT Traffic Operations Center** • DPS • Regional Coordination
Resources Required and Estimated Costs			
Projects	**Capital Improvements**	**Human Resources/Staff**	**Institutional Arrangements**
DPS CAD System Implementation (System should have export functionality as procurement specification)	*DPS CAD System*	*Project Manager* for integration of CAD system with TOC No additional staff will be required for daily operations. This will become a standard activity during incident management	*EMS/Transportation Incident Management Policy Group* *EMS/Transportation Incident Management Working Group*
To be determined	To be determined	No staff/costs identified	No costs identified
Additional Information:			
Status			
Further Consultation Required ___	Agreed Upon ___	Funded ___	Implemented ___

Table 3-13 – Function No. 12 Summary Sheet (on-scene coordination and communication)

Function No. 12 Freeway Incident Management Arterial Incident Management			
Facilitate improvement of practices for on-scene communication			
Roles and Responsibilities			
Planning	**Implementation**	**Operations**	**Maintenance**
• **DPS** • **Local Public Safety** • Fire Departments • ADOT • Regional Coordination	• **DPS** • **Local Public Safety** • Fire Departments • ADOT • Regional Coordination	• **DPS** • **Local Public Safety** • Fire Departments • ADOT • Regional Coordination	• **DPS** • **Local Public Safety** • Fire Departments • ADOT • Regional Coordination
Resources Required and Estimated Costs			
Projects	**Capital Improvements**	**Human Resources/Staff**	**Institutional Arrangements**
Transportation/ Communications Needs Analysis Study should identify communications needs of transportation incident mangement sector, for presentation to Public Safety Communications Committee (PSCC)	Inter-agency communications devices (i.e. common radio, cellular, etc.) Costs dependent upon chosen technology.	None identified	*EMS/Public Safety/Transportation Incident Management Policy and Working Groups* (previously listed) ADOT currently is represented on *PSCC (Public Safety Communications Committee)*. Communications issues between public safety/transportation should be addressed through this forum
To be determined	To Be Determined	No staff/costs identified	No costs identified
Additional Information:			
Status			
Further Consultation Required ___	Agreed Upon ___	Funded ___	Implemented ___

Table 3-14 – Function No. 13 Summary Sheet (emergency vehicles at incident scenes)

Function No. 13 Freeway Incident Management Arterial Incident Management			
Facilitate improvement of practices for placement of emergency vehicles at incident scenes			
Roles and Responsibilities			
Planning	**Implementation**	**Operations**	**Maintenance**
• **DPS** • **Local Public Safety** • **Fire Departments** • ADOT • Regional Coordination	• **DPS** • **Local Public Safety** • **Fire Departments** • ADOT	• **DPS** • **Local Public Safety** • **Fire Departments** • ADOT	• **DPS** • **Local Public Safety** • **Fire Departments** • ADOT • Regional Coordination
Resources Required and Estimated Costs			
Projects	**Capital Improvements**	**Human Resources/Staff**	**Institutional Arrangements**
Improved Practices for Placement of Emergency Vehicles at Incident Scenes Workshop, to be attended by DPS, ADOT, Local Police and Fire Departments	None identified	Project Manager/ *Coordinator* for workshop and to foster the improvement of vehicle placement practices at incidents. Staff time of local Pubic Safety agencies to review their individual vehicle placement practices	*EMS/Public Safety/Transportation Incident Management Policy Group* (previously listed) *EMS/Public Safety/Transportation Incident Management Working Group (previously listed)*
To be determined	No costs identified	.1 FTE	No costs identified
Additional Information:			
Status			
Further Consultation Required ___	Agreed Upon ___	Funded ___	Implemented ___

Table 3-15 – Function No. 14 Summary Sheet (freeway-arterial operations)

Function No. 14 Freeway-Arterial Operations			
Plan, deploy, operate, and maintain a research freeway-arterial corridor operations pilot project • Establish goals and performance expectations of system • Evaluate benefits and impacts of coordinated freeway-arterial operations			
Roles and Responsibilities			
Planning	**Implementation**	**Operations**	**Maintenance**
• **MAG** • LTMCs • ADOT Traffic Operations Center • ADOT	• **ADOT Traffic Operations Center** • LTMCs • ADOT	• **ADOT Traffic Operations Center** • LTMCs	• **ADOT Traffic Operations Center** • **LTMCs** • ADOT
Resources Required and Estimated Costs			
Projects	**Capital Improvements**	**Human Resources/Staff**	**Institutional Arrangements**
Freeway-Arterial Operations Pilot Project	*Software and Hardware for a Freeway-Arterial Operations Pilot Project*	*Project Manager* *Staff time of ADOT and local and agencies for development, implementation, operations, and review of freeway-arterial operations*	*Freeway-Arterial Operations Group*
Cost to be determined	Cost to be determined	1 FTE	No costs identified
Additional Information:			
Status			
Further Consultation Required ___	Agreed Upon ___	Funded ___	Implemented ___

Table 3-16 – Function No. 15 Summary Sheet (Arterial Incident Management Program)

Function No. 15 Arterial Incident Management			
Develop, implement, and maintain Arterial Incident Management System Pilot Project and Program, based on results of feasibility study and pilot project			
Roles and Responsibilities			
Planning	**Implementation**	**Operations**	**Maintenance**
• **MAG** • **Local Transportation** • **Local Public Safety**	• **Local Transportation Departments** • **Local Public Safety** • Regional Coordination	• **Local Public Safety** • **Local Transportation Departments** • Regional Coordination	• **Local Public Safety** • **Local Transportation Departments** • Regional Coordination
Resources Required and Estimated Costs			
Projects	**Capital Improvements**	**Human Resources/Staff**	**Institutional Arrangements**
Arterial Incident Management Project (Pilot Project, planning and development)	• *Trucks* – 3 AIM Teams (West, Central, East), of 5 Trucks each. Total annualized cost of $$350,000. • Communications system, including dispatching, paging, and in-vehicle communication	Arterial Incident Management System will require: • Project Manager/Coordinator • 3 Shift Managers/Team • 5 Field Foreperson/Team • 12 Highway Technicians/Team Annual cost of $1,338,000/Team, $4,224,000 for Region 4 Large Cities contribute $563,400 each 3 Medium Cities contribute $362,200 each 13 small cities contribute $70,400 each	*EMS/Transportation Incident Management Policy Group* *EMS/Transportation Incident Management Working Group* (previously listed) Mutual aid agreements between participating cities Cost-sharing/resource agreements between participating cities
Cost to be determined	No costs identified	See Above	No costs identified
Additional Information:			
Status			
Further Consultation Required ___	Agreed Upon ___	Funded ___	Implemented ___

Table 3-17 – Function No. 16 Summary Sheet (transit notification of incidents)

Function No. 16 Arterial Incident Management			
Facilitate practices for transit operators to notify TCC of incidents, congestion, etc. • TCC operators enter information to HCRS			
Roles and Responsibilities			
Planning	**Implementation**	**Operations**	**Maintenance**
• **Valley Metro**	• **Valley Metro**	• **Valley Metro**	• **Valley Metro**
Resources Required and Estimated Costs			
Projects	**Capital Improvements**	**Human Resources/Staff**	**Institutional Arrangements**
None identified	None identified	None identified. Practices should become part of daily activities of TCC Operator, and should be incorporated into routine training	None identified
To be determined	No costs identified	No staff/costs identified	No costs identified
Additional Information:			
Status			
Further Consultation Required ___	Agreed Upon ___	Funded ___	Implemented ___

Table 3-18 – Function No. 17 Summary Sheet (extraction of CAD information to LTMCs)

Function No. 17 Arterial Incident Management			
Facilitate agreements between agencies for extraction of CAD information, where available, for local traffic management centers			
Roles and Responsibilities			
Planning	**Implementation**	**Operations**	**Maintenance**
• **LTMCs** • Local Public Safety • Fire Departments • Regional Coordination	• **LTMCs** • Local Public Safety • Fire Departments	• **LTMCs** • Local Public Safety • Fire Departments	• **LTMCs** • Local Public Safety • Fire Departments • Regional Coordination
Resources Required and Estimated Costs			
Projects	**Capital Improvements**	**Human Resources/Staff**	**Institutional Arrangements**
City TMC/Local Public Safety CAD System Interfaces City of Mesa may present best opportunity for demonstration project	Software interface hardware, where required	*Project Manager* No additional staff will be required for daily operations. This will become a standard activity of incident management	*EMS/Transportation Incident Management Policy Group* *EMS/Transportation Incident Management Working Group*
Costs to be determined	To Be Determined	No staff/costs identified	No costs identified
Additional Information:			
Status			
Further Consultation Required ___	Agreed Upon ___	Funded ___	Implemented ___

Table 3-19 – Function No. 18 Summary Sheet (pre-set signal timing structure)

Function No. 18 Arterial Incident Management			
Develop regional pre-set signal timing structure and criteria for signal timing plan changes during incidents • Develop criteria for signal timing plan changes • Evaluate criteria after incidents, and update criteria when necessary • Assist cities in developing pre-set signal timing plans • Establish practices and procedures to notify cities/agencies and agencies of incidents that may require alteration of signal timing			
Roles and Responsibilities			
Planning	**Implementation**	**Operations**	**Maintenance**
• **MAG** • LTMCs • ADOT Traffic Operations Center • Regional Coordination	• **ADOT Traffic Operations Center** • **LTMCs** • Regional Coordination	• **ADOT Traffic Operations Center** • **LTMCs**	• **ADOT Traffic Operations Center** • **LTMCs** • Regional Coordination
Resources Required and Estimated Costs			
Projects	**Capital Improvements**	**Human Resources/Staff**	**Institutional Arrangements**
• *Standard Interagency Response Plan for Incident Collaboration within the MAG Region,* which will include: - Development of criteria for alteration of signal timing plans during incidents, including: - Procedures to request signal timing adjustments during incidents - Procedures to restore signal timing to normal operations • *Regional Traffic Engineering Collaboration Program*, which will include alternate signal timing plans for freeway alternate routes	*Center-to-Center communications* between all agencies *Interface (Software and Hardware, if necessary)* at ADOT Traffic Operations Center to establish interoperability between city signal systems See Multi-agencies Coordination for cost information	A *Project Manager* for Regional Traffic Engineering Collaboration Program, and Standard Interagency Response Plan for Incident Collaboration Local agency staff time will be required to participate and to assist in development and review of alternate signal timing plans	*EMS/Public Safety/Transportation Incident Management Policy Group* *EMS/Public Safety/Transportation Incident Management Working Group* *Regional Traffic Engineering Collaboration Program Steering Group*
Costs to be determined	No costs identified	No staff/costs identified	No costs identified
Additional Information:			
Status			
Further Consultation Required ___	Agreed Upon ___	Funded ___	Implemented ___

Table 3-20 – Function No. 19 Summary Sheet (standards for EVSP)

Function No. 19 Arterial Incident Management			
Develop regionally accepted standard for emergency vehicle signal preemption • Ensure common understanding of standard among all affected agencies (fire and transportation) • Update standard, when necessary			
Roles and Responsibilities			
Planning	**Implementation**	**Operations**	**Maintenance**
• **LTMCs** • Fire Departments • Regional Coordination	• **LTMCs** • Fire Departments	• **LTMCs** • Fire Departments	• **LTMCs** • Local Transportation Departments • Fire Departments • Regional Coordination
Resources Required and Estimated Costs			
Projects	**Capital Improvements**	**Human Resources/Staff**	**Institutional Arrangements**
Regional Standard Guidelines for Implementation of EVSP	New signals should implement EVSP consistent with standard. Existing signals may be upgraded in conjunction with other signal upgrade modification projects EVSP firmware/hardware located in controller cabinets (if necessary) (approx. $3,000/int.) Second emitter (if necessary). A second emitter may be required on each fire truck. ($800/ per fire truck)	No additional staff is required to implement EVSP on new signals.	*EMS/Transportation Incident Management Policy Group* *EMS/Transportation Incident Management Working Group* *EVSP Steering Group*
Costs to be determined	To Be Determined	No staff/costs identified	No costs identified
Additional Information: Regional standard should be implemented on all new traffic signals. Implementation of hardware/firmware required for EVSP on existing signals can be done as part of local agency capital construction program as new signals are constructed or existing signals are upgraded			
Status			
Further Consultation Required ___	Agreed Upon ___	Funded ___	Implemented ___

Table 3-21 – Function No. 20 Summary Sheet (Transit Signal Priority)

Function No. 20			Transit Mobility
Plan, deploy, operate, maintain and evaluate a Transit Signal Priority system • Establish goals and performance expectations of TSP • Evaluate benefits and impacts of TSP			
Roles and Responsibilities			
Planning	**Implementation**	**Operations**	**Maintenance**
• **Valley Metro** • **MAG** • Regional Coordination	• **Valley Metro** • LTMCs	• **Valley Metro** • LTMCs	• **Valley Metro** • LTMCs
Resources Required and Estimated Costs			
Projects	**Capital Improvements**	**Human Resources/Staff**	**Institutional Arrangements**
TSP Pilot Project Implementation and Evaluation	• Bus equipment • Transit management system modifications • Traffic signal system modifications Costs have ranged from $8,000-$35,000 per int.	Project Manager Staff time from each of the involved Local Traffic Management Centers, as well as from Valley Metro. Once implemented, system will be monitored by LTMC/Valley Metro as part of normal system operations.	*Transit Signal Priority Group* Most critical relationship is between the transit agency and the signal system operators
Costs to be determined	Costs to be determined	.2 FTE	No costs identified
Additional Information:			
Status			
Further Consultation Required ___	Agreed Upon ___	Funded ___	Implemented ___

Table 3-22 – Function No. 21 Summary Sheet (maintenance of local systems)

Function No. 21 Maintenance and Reliability			
Traffic signal systems maintenance and repair, including field devices and central system • Perform routine preventive maintenance of field devices (CCTV, VMS, Traffic Signals, Detectors) • Repair failures as soon as possible (cable breaks, etc.)			
Roles and Responsibilities			
Planning	**Implementation**	**Operations**	**Maintenance**
• **LTMCs** • Local Transportation Departments • ADOT Traffic Operations Center • Regional Coordination	• N/A	• N/A	• **LTMCs** • Local Transportation Departments • ADOT Traffic Operations Center
Resources Required and Estimated Costs			
Projects	**Capital Improvements**	**Human Resources/Staff**	**Institutional Arrangements**
Maintenance of agency-owned operations-oriented infrastructure	Maintenance equipment dependent upon the needs of the region. Equipment could be procured at a regional level for shared use by local agencies	*Maintenance staff* commensurate with the number of ITS field devices within a city (small, medium, large, as explained in Section 6)	*Shared Maintenance and Resources Group*
Costs to be determined	Costs to be determined	To Be Determined	No costs identified
Additional Information:			
Status			
Further Consultation Required ___	Agreed Upon ___	Funded ___	Implemented ___

Table 3-23 – Function No. 22 Summary Sheet (maintenance of regional systems)

Function No. 22 Maintenance and Reliability			
Maintenance of central control systems, including regional systems housed in the ADOT TOC • Repair failures/breaks as soon as possible			
Roles and Responsibilities			
Planning	**Implementation**	**Operations**	**Maintenance**
• **ADOT Traffic Operations Center** • LTMCs • Regional Coordination	• **ADOT Traffic Operations Center** • LTMCs	• **ADOT Traffic Operations Center** • LTMCs	• **ADOT Traffic Operations Center** • LTMCs
Resources Required and Estimated Costs			
Projects	**Capital Improvements**	**Human Resources/Staff**	**Institutional Arrangements**
Maintenance of regional systems	None identified	*Maintenance Supervisor* *Maintenance staff* commensurate with the number of ITS field devices within a city (small, medium, large, as explained in Section 6)	*Shared Maintenance and Resources Group*
To Be Determined	No costs identified	To Be Determined	No costs identified
Additional Information: Maintenance services also could be procured contractually at a regional level.			
Status			
Further Consultation Required ___	Agreed Upon ___	Funded ___	Implemented ___

Table 3-24 – Function No. 23 Summary Sheet (maintenance of regional communications)

Function No. 23 Maintenance and Reliability			
Maintain regionally significant communications (fiber-optic, other) lines • Repair failures promptly			
Roles and Responsibilities			
Planning	**Implementation**	**Operations**	**Maintenance**
• **ADOT Traffic Operations Center** • LTMCs • Local Transportation Departments • Regional Coordination	• N/A	• N/A	• **ADOT Traffic Operations Center** • LTMCs • Local Transportation Departments • Regional Coordination
Resources Required and Estimated Costs			
Projects	**Capital Improvements**	**Human Resources/Staff**	**Institutional Arrangements**
Maintenance of center-to-center communications	None identified	*Maintenance staff* commensurate with the number of ITS field devices within a city (small, medium, large, as explained in Section 6)	*Shared Maintenance and Resources Group* *Center-to-Center Communications Group*
Costs to be determined	No costs identified	To Be Determined	No costs identified
Additional Information: Maintenance services also could be procured contractually at a regional level.			
Status			
Further Consultation Required ___	Agreed Upon ___	Funded ___	Implemented ___

Table 3-25 – Function No. 24 Summary Sheet (cost sharing agreements)

Function No. 24 Maintenance and Reliability			
Develop and maintain cost sharing agreements such as pooled funding, JPAs, manage multi-jurisdictional resources (shared human resources, equipment, etc.) • Shared equipment • Pooled funding/Joint Project Agreements • Contracted services • Accounting and reporting procedures • Management of multi-jurisdictional resources, shared labor (stand-by team)			
Roles and Responsibilities			
Planning	**Implementation**	**Operations**	**Maintenance**
• **MAG** • Local Transportation Departments • ADOT Traffic Operations Center	• **MAG** • Local Transportation Departments • ADOT Traffic Operations Center	• **ADOT Traffic Operations Center** • Local Transportation Departments	• **MAG** • Local Transportation Departments • Regional Coordination
Resources Required and Estimated Costs			
Projects	**Capital Improvements**	**Human Resources/Staff**	**Institutional Arrangements**
Cost and Maintenance Resources Sharing Agreements for MAG Agencies	Depending upon regional needs, equipment could be procured at a regional level. Alternatively, all equipment would be agency owned, and loaned to the region as required.	Project Manager to manage shared maintenance and resources If pooled staff resources are implemented, each agency would contribute staff time to regional maintenance commensurate with the number of field devices/miles of communication Alternatively, funds could be pooled	*Shared Maintenance and Resources Group.* Responsible for pooled resource agreements for • Agency after-hours on-call maintenance personnel, or contractor for critical breaks • Specialized equipment Agreements (bucket trucks, fiber equip.)
Costs to be determined	To Be Determined	.25 FTE	No costs identified
Additional Information:			
Status			
Further Consultation Required ___	Agreed Upon ___	Funded ___	Implemented ___

Table 3-26 – Function No. 25 Summary Sheet (center-to-center communications)

Function No. 25 Multi-agencies Coordination			
Establish center-to-center communications between agencies			
Roles and Responsibilities			
Planning	**Implementation**	**Operations**	**Maintenance**
• **MAG**	• **ADOT Traffic Operations Center** • MAG • Local TMCs	• **ADOT Traffic Operations Center** • Local TMCs	• **ADOT Traffic Operations Center** • Local TMCs
Resources Required and Estimated Costs			
Projects	**Capital Improvements**	**Human Resources/Staff**	**Institutional Arrangements**
Various *Center to Center-Communications Projects* (Planning and Design)	*Center-to-center communications* between TOC, LTMCs, and Public Safety Centers $660,000 annual maintenance costs	Maintenance staff for center-to-center communications. May be dedicated staff or contractual staff	*Center-to-Center Communications Group*
To Be Determined	Costs to be determined	To be determined	No costs identified
Additional Information:			
Status			
Further Consultation Required ___	Agreed Upon ___	Funded ___	Implemented ___

Table 3-27 – Function No. 26 Summary Sheet (data archiving system)

Function No. 26 Multi-agencies Coordination			
Develop and implement a regional data archiving system • Data uses • Data requirements (including consistent file formats)			
Roles and Responsibilities			
Planning	**Implementation**	**Operations**	**Maintenance**
• **MAG**	• **MCDOT**	• ADOT Traffic Operations Center • LTMCs	• **ADOT Traffic Operations Center** • LTMCs
Resources Required and Estimated Costs			
Projects	**Capital Improvements**	**Human Resources/Staff**	**Institutional Arrangements**
Regional Data Archiving System (Already funded)	*Regional Data Archiving System* (software and hardware, if needed) *(Already funded)*	The regional data transfer and data archiving system will require: • *Project Manager* • *Staff time* of Local Traffic Management Centers, ADOT TOC to upload data to system	*Archived Data Group*
No costs identified	No costs identified	.1 FTE (Project Manager) .1 FTE (Staff time of local agencies)	No costs identified
Additional Information:			
Status			
Further Consultation Required ___	Agreed Upon ___	Funded ___	Implemented ___

Table 3-28 – Function No. 27 Summary Sheet (after-hours signal system monitoring)

Function No. 27	Multi-agencies Coordination		
Develop practices for after-hours/extended hours monitoring of local TMC systems and devices • Monitor traffic signal systems of multiple agencies • Contact owning agency when incident requires altering of signal timing plans • Contact owning agency when critical system failure occurs			
Roles and Responsibilities			
Planning	**Implementation**	**Operations**	**Maintenance**
• **LTMCs** • **ADOT Traffic Operations Center**	• **LTMCs** • **ADOT Traffic Operations Center** • Regional Coordination	• **LTMCs** • **ADOT Traffic Operations Center**	• **LTMCs** • **ADOT Traffic Operations Center**
Resources Required and Estimated Costs			
Projects	**Capital Improvements**	**Human Resources/Staff**	**Institutional Arrangements**
Remote Signal System Operations Implementation at ADOT Traffic Operations Center	Software and Hardware	Extended hours of traffic signal system monitoring will be achieved by local agencies staff contributions, commensurate with the number of field devices and communication	*LTMC/TOC Operators Group*
Costs to be determined	Costs to be determined	To be determined	No costs identified
Additional Information:			
Status			
Further Consultation Required ___	Agreed Upon ___	Funded ___	Implemented ___

Table 3-29 – Function No. 28 Summary Sheet (inter-agency incident notification)

Function No. 28 Multi-agencies Coordination			
Facilitate practices to notify other agencies of incidents/work zones that may significantly impact traffic			
Roles and Responsibilities			
Planning	**Implementation**	**Operations**	**Maintenance**
• **ADOT Traffic Operations Center** • LTMCs	• **ADOT Traffic Operations Center** • LTMCs • DPS	• **ADOT Traffic Operations Center** • DPS • LTMCs	• **ADOT Traffic Operations Center**
Resources Required and Estimated Costs			
Projects	**Capital Improvements**	**Human Resources/Staff**	**Institutional Arrangements**
Web enabled Incident Notification Directory (paging telephone, and email). Directory should be maintained on a regular basis – developed and maintained internally by TOC	None identified	No additional TOC operators will be required. The notification of agencies of incidents will need to become a routine practice of existing operators.	*LTMC/TOC Operators Group*
Costs to be determined	No costs identified	No staff/costs identified	No costs identified
Additional Information:			
Status			
Further Consultation Required ___	Agreed Upon ___	Funded ___	Implemented ___

Table 3-30 – Function No. 29 Summary Sheet (local information to HCRS and/or 511)

Function No. 29		Travel Information	
Make available work zone and incident and transit information to HCRS and/or 511 • Input maintenance and work zone activities into HCRS			
Roles and Responsibilities			
Planning	**Implementation**	**Operations**	**Maintenance**
• **LTMCs** • ADOT Traffic Operations Center	• **LTMCs** • Local Transportation Departments • ADOT Traffic Operations Center	• **LTMCs** • Local Transportation Departments • ADOT Traffic Operations Center	• **LTMCs** • Local Transportation Departments • ADOT Traffic Operations Center
Resources Required and Estimated Costs			
Projects	**Capital Improvements**	**Human Resources/Staff**	**Institutional Arrangements**
System Integration of HCRS into AZTech™ System and Network	None identified	Local staff will be required to enter planned closure information into HCRS. Consider integration with permitting process.	Include agreement in MOU
Costs to be determined	No costs identified	.1 FTE	No costs identified
Additional Information: Assumptions: 1. Communications infrastructure and costs not included 2. HCRS software to be made available by ADOT for integration into HCRS 3. HCRS training is provided by ADOT 4. No additional costs for HCRS development are required 5. Cities will be able to use current AZTech™ workstations			
Status			
Further Consultation Required ___	Agreed Upon ___	Funded ___	Implemented ___

Table 3-31 – Function No. 30 Summary Sheet (transit information to 511)

Function No. 30		Travel Information	
Integrate transit information with travel information services (e.g. provide AVL data to 511)			
Roles and Responsibilities			
Planning	**Implementation**	**Operations**	**Maintenance**
• **Valley Metro** • **ADOT**	• **Valley Metro** • ADOT	• **Valley Metro** • ADOT	• **Valley Metro** • ADOT
Resources Required and Estimated Costs			
Projects	**Capital Improvements**	**Human Resources/Staff**	**Institutional Arrangements**
AVL Integration with 511	Hardware/Software Interface for AVL into 511 system	*Project Manager* Staff resources from Transit and ADOT to Implement system. Once functional, system will require minimal staff resources except for routine system maintenance	*Travel Information Group*
Costs to be determined	Costs to be determined	.2 FTE	No costs identified
Additional Information:			
Status			
Further Consultation Required ___	Agreed Upon ___	Funded ___	Implemented ___

Table 3-32 – Function No. 31 Summary Sheet (arterial detection)

Function No. 31	Travel Information		
Develop practices for collection of information from arterial detectors for travel information services • Ensure that data from existing deployed detectors is available • Explore expansion of arterial detection through new technology			
Roles and Responsibilities			
Planning	**Implementation**	**Operations**	**Maintenance**
• **LTMCs** • ADOT • Regional Coordination	• **LTMCs** • ADOT	• **LTMCs** • ADOT	• **LTMCs** • ADOT
Resources Required and Estimated Costs			
Projects	**Capital Improvements**	**Human Resources/Staff**	**Institutional Arrangements**
MCDOT Data Gap Assessment Study (in progress)		*Project Manager* Staff to maintain system and coordinate regional data collection efforts	*Travel Information Group*
Costs to be determined	Costs to be determined	$300,000	No costs identified
Additional Information:			
Status			
Further Consultation Required ___	Agreed Upon ___	Funded ___	Implemented ___

Table 3-33 – Function No. 32 Summary Sheet (post travel information/messages)

Function No. 32			Travel Information
Post travel information/messages on freeway and arterial VMS and on internet • Expand dissemination of arterial information through multiple media			
Roles and Responsibilities			
Planning	**Implementation**	**Operations**	**Maintenance**
• **LTMCs** • **ADOT Traffic Operations Center** • Regional Coordination	• **LTMCs** • **ADOT Traffic Operations Center**	• **LTMCs** • **ADOT Traffic Operations Center**	• **LTMCs** • **ADOT Traffic Operations Center**
Resources Required and Estimated Costs			
Projects	**Capital Improvements**	**Human Resources/Staff**	**Institutional Arrangements**
Integration of HCRS with AZTech™ system, and other local systems	Hardware, software, arterial detection	*Project Manager*	*Travel Information Group*
Costs to be determined	Costs to be determined	.25 FTE	No costs identified
Additional Information: Integrate ADOT FMS/AZTech/HCRS servers at ADOT TOC to provide integrated traveler information/traffic management system			
Status			
Further Consultation Required ___	Agreed Upon ___	Funded ___	Implemented ___

Table 3-34– Function No. 33 Summary Sheet (market travel information services)

Function No. 33 Travel Information			
Market Travel Information Services			
Roles and Responsibilities			
Planning	**Implementation**	**Operations**	**Maintenance**
• **ADOT Traffic Operations Center** • Arizona Motor Vehicle Division • AZTech • Regional Coordination	• **ADOT Traffic Operations Center** • Arizona Motor Vehicle Division • AZTech • Regional Coordination	• **ADOT Traffic Operations Center** • Arizona Motor Vehicle Division • AZTech • Regional Coordination	• **ADOT Traffic Operations Center** • Arizona Motor Vehicle Division • AZTech
Resources Required and Estimated Costs			
Projects	**Capital Improvements**	**Human Resources/Staff**	**Institutional Arrangements**
Travel Information Outreach Campaign	None identified	Project Manager	Travel Information Group
Costs to be determined		.25 FTE	No costs identified
Additional Information: Consider marketing efforts such as the inclusion of information about travel information at Arizona Motor Vehicle Division and inclusion in registration renewal notices, etc.			
Status			
Further Consultation Required ___	Agreed Upon ___	Funded ___	Implemented ___

4. INSTITUTIONAL ARRANGEMENTS REQUIRED TO IMPLEMENT THE CONCEPT OF OPERATIONS

The purpose of this section is:

- To concisely summarize the functions presented in the *Function Summary Sheets* and the institutional arrangements required to implement the functions;
- To review existing institutional relationships for transportation systems operations in the MAG Region. A more in-depth discussion of existing institutional relationships for transportation operations in the MAG Region is found in Tech Memo No. 1: Vision, Mission, and Summary of Existing Regional Policies and Practices in Transportation Operations; and
- To identify existing or additional relationships and groups required to implement the Regional Concept of Transportation Operations.

4.1 Association of Required Institutional Relationships with Functions

The *Function Summary Sheets* (section 3) listed the agencies that will participate in planning, implementing, operating, and maintaining the transportation systems and projects necessary to carry out the functions. The *Function Summary Sheets* also identify *Institutional Arrangements* that will be required to implement the functions. These were presented without identifying specific groups or individuals.

Table 4-1 presents each of the required *Institutional Arrangements* identified in the *Function Summary Sheets* and its associated functions. The *Institutional Arrangements* shown in the table are not existing programs or groups. Although the names are similar to those of existing groups, they are only intended to identify the type of institutional arrangements that are needed. The extent to which existing groups fulfill the necessary institutional arrangements is discussed in section 4.3.

Table 4-1 – Institutional Arrangements Identified in *Function Summary Sheets* and their Associated Functions

Institutional Arrangement	Associated Function
Regional Traffic Signal Optimization Program Group	Function 2 (intra-city signal systems operations)
	Function 3 (inter-city signal systems operations)
	Function 18 (pre-set signal timing structure)
EMS/Public Safety/Transportation Incident Management Policy Group, and EMS/Public Safety/Transportation Incident Management Working Group	Function 4 (incident management practices)
	Function 5 (incident debriefing sessions)
	Function 6 (interagency incident response plan)
	Function 11 (extraction of CAD information to TOC/511)
	Function 9 (towing and recovery vehicles)
	Function 12 (on-scene coordination and communication)
	Function 13 (emergency vehicles at incident scenes)
	Function 15 (Arterial Incident Management Program)
	Function 17 (extraction of CAD information to LTMCs)
	Function 18 (pre-set signal timing structure)

Table 4-1 – Institutional Arrangements Identified in *Function Summary Sheets* and their Associated Functions (continued)

Institutional Arrangement	Associated Function
Shared Maintenance and Resources Group	Function 21 (maintenance of local systems)
	Function 22 (maintenance of regional systems)
	Function 23 (maintenance of regional communications)
	Function 24 (cost sharing agreements)
Education and Outreach Group	Function 10 (quick clearance laws education)
Freeway-Arterial Operations Group	Function 14 (freeway-arterial operations)
Emergency Vehicle Signal Preemption Group	Function 19 (standards for emergency vehicle signal preemption)
Transit Signal Priority Group	Function 20 (Transit Signal Priority)
Center-to-Center Communications Group	Function 25 (center-to-center communications)
Archived Data Group	Function 26 (data archiving system)
LTMC/TOC Operators Group	Function 7 (personnel and logistics resource list)
	Function 27 (after-hours signal system monitoring)
	Function 28 (inter-agency notification)
Travel Information Group	Function 29 (local information to HCRS and/or 511)
	Function 30 (transit information to 511)
	Function 31 (arterial detection)
	Function 32 (post travel information/messages)
	Function 33 (market travel information)
The following functions do not require institutional arrangements	Function 1 (ramp metering operations)
	Function 8 (ADOT ALERT/FSP operations)
	Function 16 (transit notification of incidents)

4.2 Existing Institutional Arrangements for ITS Operations

Several formal and informal organized functions or groups exist within the MAG Region that currently forms the framework for coordination of transportation operations. These groups are discussed below.

- MAG ITS Committee;
- AZTech™ (Working Groups and Strategy Groups);
- East Valley Signal Timing Group; and
- West Valley Signal Timing Signal Group.

4.2.1 MAG Regional Council, Management Committee, Transportation Review Committee, ITS Committee, and Stakeholder Groups

The MAG Council and Committees are made up of federal, state, and local transportation agencies in the Phoenix metropolitan region.

The primary role of the MAG ITS Committee is to plan all regional ITS infrastructure and recommend regional investments in ITS. The meetings of the Committee, which occur every month, also provide a formal avenue for inter-agency cooperation and coordination on matters pertaining to ITS and regional traffic management.

4.2.2 AZTech™

AZTech™ is a voluntary consortium of federal, state, local agencies, and private sector partners within the Phoenix metropolitan area. There is no established formal link between AZTech™ Executive Committee and the regional transportation planning process. Core members include transportation and transit agencies, fire departments, police departments, and emergency management agencies. Within the AZTech™ framework are two additional layers: Working Groups and Strategy Groups.

The AZTech™ Working Groups meet bi-monthly to discuss technical issues. The working groups are:

- Mass Evacuation Planning;
- Advanced Traveler Information Systems (initiated in 2003, has not yet met);
- Technical Oversight/Traffic Operations Working Group (now called the Operations Committee);
- TMC Operators; and
- Incident Management.

The Strategy Groups meet on an as-needed basis at the direction of the Executive Committee, and include:

- Education and Outreach;
- Expand and Strengthen Partnerships;
- Develop and Deploy Integrate Systems;
- Organize Regional Operations;
- Research and Test New Technological Opportunities; and
- Cultivate Funding and Resource Opportunities (initiated in 2003, has not yet met).

4.2.3 Traffic Signal Timing Groups

Less formally organized groups also provide forums for coordination of traffic operations. These are the East Valley Traffic Signal group and West Valley Traffic Signal group. The Valley Traffic Signal Groups deal with traffic signal operations and management issues that are specific to each geographic area.

4.2.4 Summary

Three categories of functions that provide a framework for coordination of transportation operations have been identified. A summary of these functions is shown in **Table 4-2**.

Table 4-2 – Organization and Function of Existing Regional Consortiums

Framework	Activities	Level of Participation	Frequency
MAG ITS Committee Standing committee at the MPO Established source of federal funding	• Planning and prioritization of all regional ITS infrastructure	Transportation officials from all MAG member agencies, ADOT, FHWA, Sky Harbor and DPS.	Monthly meetings.
AZTech™ Informal group No established funding stream	• Inter-agency coordination • Traffic management • Incident management • Emergency management	All major agencies within Maricopa County attend, including transportation, fire, police, and emergency management.	At least one AZTech™ meeting occurs every month. Executive Committee meets every two months.
Traffic Signal Timing Groups No established funding stream	• Signal operations • Traffic management • Inter-agency coordination • ITS equipment and use	All affected transportation agencies generally have representation.	Meetings occur approximately every quarter. There is no formal schedule.

The relationship between the MAG ITS Committee and the AZTech™ Executive Committee, as defined in the MAG ITS Strategic Plan Update (2000) is shown in **Figure 4-1**. The institutional framework focuses on the planning and operations of ITS, and emphasizes the close coordination required between these two functions.

In the MAG ITS Strategic Plan Update (2000), it was agreed that the MAG Regional Council, Management Committee, Transportation Review Committee and ITS Committee will have primary responsibilities for ITS planning in the region. Specific responsibilities of these groups will include:

- Regional infrastructure planning;
- Regional operations planning;
- Regional standards and architecture;
- Performance measures and evaluation;
- Regional telecommunications infrastructure;
- Public outreach; and
- Training and capacity building.

As stated in the MAG ITS Strategic Plan, the AZTech™ Executive Committee and Working Groups have primary responsibility for regional ITS operations. Specific operational responsibilities of the AZTech™ Executive Committee and Working Groups include:

- Incident management coordination;
- Signal timing;

- Traveler information services;
- Transit operations;
- Traffic management coordination;
- Event management;
- Parking management;
- Regional transportation network management;
- Public outreach; and
- Training and capacity building.

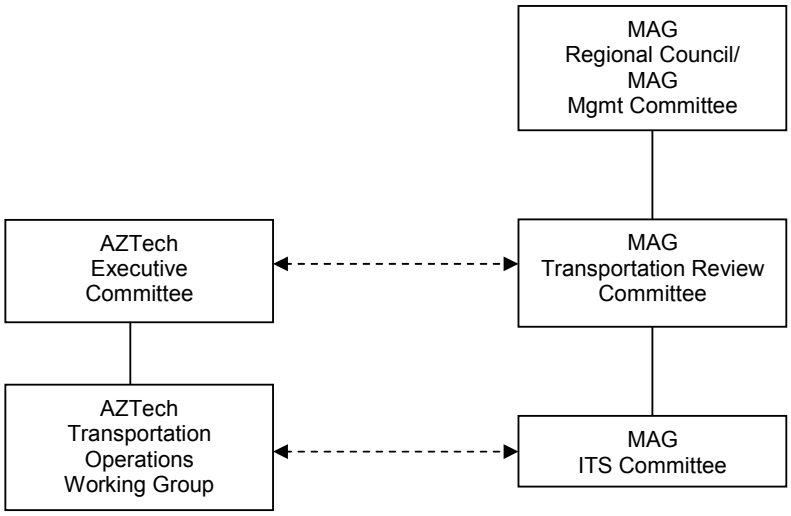

Figure 4-1 – Existing Institutional Relationships for transportation operations in the MAG Region

4.3 Alignment of Needs and Existing Regional Forums

The purpose of this section is to align the institutional needs identified in the *Function Summary Sheets* with existing regional forums. This will help to determine which, if any, new regional groups and forums are required or whether the specific functions can be added to existing agendas. **Table 4-3** lists the institutional need identified in the *Function Summary Sheets* and existing regional forums that may satisfy, in part or in full, the need.

Table 4-3 – Alignment of Needed Institutional Arrangements and Existing Forums

Needed Institutional Arrangements as Identified in Function Summary Sheets	Existing Forums
Regional Coordination	MAG ITS Committee
	AZTech™ Executive Committee
EMS/Public Safety/Transportation Incident Management Policy Group	None currently fulfills
EMS/Public Safety/Transportation Incident Management Working Group	AZTech™ Incident Management Working Group (partly)
Freeway-Arterial Operation Working Group	None currently fulfill
Transit Signal Priority Working Group	None currently fulfill
Shared Maintenance and Resources Group	None currently fulfill
Center-to-Center Communications Working Group	MAG ITS Committee (funding)
	MAG Telecommunications Advisory Group (MAG TAG)
	AZTech™ Operations Committee
Archived Data Group	None currently fulfill management role
	MAG ITS Committee (provides funding)
Local Traffic Management Centers/ADOT Traffic Operations Center Operators Group	AZTech™ TMC Operators
Travel Information Group	AZTech™ ATIS Working Group
Emergency Vehicle Signal Preemption (EVSP) Steering Group	None currently fulfill
Regional Traffic Signal Optimization Program Group	MAG ITS Committee
	AZTech™ East Valley and West Valley Traffic Signal Timing Groups
Education and Outreach Group	None currently fulfill

As seen in **Table 4-3**, the following *Needed Institutional Arrangements* are not aligned with an existing forum.

- EMS/Public Safety/Transportation Incident Management;
- Freeway-Arterial Operations;
- Transit Signal Priority;
- Shared Maintenance and Resources;
- Emergency Vehicle Signal Preemption ; and
- Education and Outreach.

4.4 Elements of Institutional Framework

The objective of this section is to describe the elements of a framework that are necessary for transportation managers, public safety and fire department officials to build sustained relationships and create strategies to improve transportation operations in the MAG Region.

A successful institutional framework will address three key areas:

- Governance, Policy and Decision-Making;
- Provision of Resources; and
- Championing of Local and Regional Functions.

4.4.1 Governance, Policy, and Decision-Making

The governance, policy and decision-making element of the institutional framework provides the set of relationships that enable regional collaboration, coordination, and communication among partner members and agencies. This can be thought of as the "table" (literally and figuratively) around which operators and service providers meet to discuss regional needs and possibilities for improving transportation system operations (1).

Implementation of the Concept of Transportation Operations may require two types of governing and decision-making groups. First, a policy group comprised of decision-makers from transportation, public safety, and fire agencies is needed. Second, technical advisory forums comprised of managers and technical professionals are needed to implement the decisions of the policy-making body.

It is critical that the individuals on the policy-making body have authority to commit agency resources. They will assume authority, accountability, and overall responsibility for adopting policies, developing consensus among stakeholders, facilitating the sharing of resources and infrastructure, and committing the staffing and funding necessary to implement the functions identified in the concept of operations (1).

To be effective, the governance and policy-making body must be linked to the regional transportation planning process. For regional collaboration to work, it must be on-going, and not tied to specific projects or special events (1).

Governing and decision-making bodies may range from informal, ad hoc arrangements to formal, legal entities with dedicated resources and staff. The range of potential organizational approaches is seen in **Table 4-4** (1).

Table 4-4 – Range of Organizational Approaches (1)

Less Formal ◄——► More Formal				
Ad hoc arrangements based on near-term issues, personal relationships and interests	Informal working groups that meet regularly to address topics of regional significance	Formally established joint working group with assigned responsibilities	Funded entities with full-time staff and well-defined responsibilities related to collaboration	Legal entities with dedicated resources, authorities, and governing boards that represent agencies and jurisdictions

4.4.2 Provision of Resources

After policy decision and direction has been made, resources must be committed. Regional operations and collaboration can only be achieved if individuals and agencies commit the appropriate funding, staffing, and equipment required to improve transportation system performance.

Funding, Acquisition, and Procurement

Operations of transportation systems must be viewed as a priority of participating agencies and organizations. The key to a commitment of sustained resources lies in ensuring that all participants see the benefits of their contributions, both to the region and to their own agency (1).

Funding for operations may come from individual agency budgets or be designated in the regional transportation planning process. Funding from individual agency budgets may involve agreements to share equipment and personnel across jurisdictional boundaries, and agreements on acquisition and procurement.

The regional transportation planning process may allocate funding for capital investments in operations-related infrastructure to be deployed on a regional basis or in conjunction with other capital improvement projects. Funding for such projects requires operating agencies to have a role in the region's capital planning process, and that regional planners have an operating vision (1).

Finally, procedures for the acquisition and procurement of regional solutions should be identified. Regional acquisition and procurement procedures should address the negotiation of contracts for obtaining services, equipment procurement, and administration of construction projects for new operations oriented infrastructure.

Staffing

Effective regional collaboration and coordination depends on the availability of qualified staff and resources to do the work needed to support the functions identified in the Concept of Transportation Operations. Interagency or interregional positions may be needed to facilitate the collaboration among organizations and jurisdictions.

Human resources may be applied in the form of in-kind contributions from participating organizations or through programs administered by a single agency on behalf of the region. The range of possible resource strategies ranges from the informal to the formal (1).

Table 4-4 – Range of Resource Strategies (1)

Less Formal ◄——► More Formal		
In Kind	**Pooled Resources**	**Funded Entity**
• Individuals commit to periodic meetings to address issues of regional significance. • Agencies assign staff members and other resources (equipment, facilities) to support collaboration efforts on an on-going basis.	• Jurisdictions and public and private organizations pool funds, people, assets, and other resources to sustain collaboration • Agencies and jurisdictions commit resources (people, assets) to be used in regional operating activities (e.g. mutual assistance agreements)	• Jurisdictions and public and private organizations allocate funds to support a regional entity responsible for regional collaboration • Entities are formed and funded to own and operate assets (e.g. transit systems, maintenance vehicles, emergency response assets) on behalf of multiple jurisdictions

4.4.3 Implementation of Local and Regional Functions

Experience shows that little happens unless someone or some group of people is committed to making it happen. Thus, the third critical element of a successful institutional framework is the identification of champions for each of the functions. These champions should be committed to working together in support of better regional transportation system performance (1).

Group/ Initiative Champions

Each of the initiatives (e.g. Freeway-Arterial Operations Group, Shared Maintenance and Resource Group) identified in the *Function Summary Sheets* requires the designation of an agency or individual to act as an *initiative champion.* The *initiative* champion will*:*

- Act as a catalyst for bringing appropriate group together;
- Elevate pertinent issues to the appropriate committees;
- Provide initiative leadership and possibly administrative support (if required).);
- Be responsible for presentations and progress updates to committees;
- Coordinate the work planning, implementation, operation, and maintenance of relevant activities and projects; and
- Facilitate coordination with stakeholders and information sharing, serve as technical contact/advisor for projects.

Table 4-4 summarizes the required *initiative champion* and *agency* roles. The first column contains the assigned Group Champion. Columns two through five contain the agencies involved in the planning, implementation, operations, and maintenance of the function activities. The last column contains the function description.

Table 4-4 – Summary of Agency Responsibilities

Oversight and Scoping	Involved Agencies				Associated Function
	Planning	Implementation	Operations	Maintenance	
Regional Traffic Signal Optimization Program Group Initiative Champion: Mike Mah, City of Chandler	MAG	LTMCs	LTMCs	LTMCs	Function 2 (intra-city signal systems operations)
	MAG	LTMCs	LTMCs	LTMCs	Function 3 (inter-city signal systems operations)
	MAG	ADOT TOC LTMCs	ADOT TOC LTMCs	ADOT TOC LTMCs	Function 18 (pre-set signal timing structure)
EMS/Public Safety/Transportation Incident Management Policy and Working Groups, Initiative Champion: Tim Wolfe , ADOT TOC (Freeways), and Faisal Saleem, and Barbara Hauser, MCDOT, (Arterials)	DPS Local Public Safety	DPS Local Public Safety	DPS Local Public Safety	DPS Local Public Safety	Function 4 (incident management practices)
	DPS Local Public Safety	DPS Local Public Safety	DPS Local Public Safety	DPS Local Public Safety	Function 5 (incident debriefing sessions)
	ADOT TOC	ADOT TOC	ADOT TOC	ADOT TOC	Function 6 (interagency incident response plan)
	ADOT TOC	ADOT TOC	ADOT TOC	ADOT TOC	Function 11 (extraction of CAD information to TOC/511)
	DPS Local Public Safety	DPS Local Public Safety	DPS Local Public Safety	DPS Local Public Safety	Function 12 (on-scene coordination and communication)
	DPS Local Public Safety	DPS Local Public Safety	DPS Local Public Safety	DPS Local Public Safety	Function 13 (emergency vehicles at incident scenes)

Table 4-4 – Summary of Agency Responsibilities (continued)

Oversight and Scoping	Involved Agencies				Associated Function
	Planning	Implementation	Operations	Maintenance	
Continued: EMS/Public Safety/Transportation Incident Management Policy and Working Groups, Initiative Champion: Tim Wolfe , ADOT TOC (Freeways), and Faisal Saleem, and Barbara Hauser, MCDOT, (Arterials)	MAG	Local Public Safety Local Trans. Dept.	Local Public Safety Local Trans. Dept.	Local Public Safety Local Trans. Dept.	Function 15 (Arterial Incident Management Program)
	LTMCs*	LTMCs	LTMCs	LTMCs	Function 17 (extraction of CAD information to LTMCs)
Shared Maintenance and Resources Group Initiative Champion: Tim Wolfe, and Darrell Bingham, ADOT TOC	ADOT TOC	ADOT TOC	ADOT TOC	ADOT TOC	Function 7 (personnel and logistics resource list)
	DPS	DPS	DPS	DPS	Function 9 (towing and recovery vehicles)
	LTMCs	N/A	N/A	LTMCs	Function 21 (maintenance of local systems)
	ADOT TOC	ADOT TOC	ADOT TOC	ADOT TOC	Function 22 (maintenance of regional systems)
	ADOT TOC	N/A	N/A	ADOT TOC	Function 23 (maintenance of regional communications)
	MAG	MAG	ADOT TOC	MAG	Function 24 (cost sharing agreements)
Education and Outreach Group Initiative Champion: To be coordinated with Governor's Office of Highway Safety	GOHS	GOHS	GOHS	GOHS	Function 10 (quick clearance laws education)
Freeway-Arterial Operations Group Initiative Champion: Bruce Dressel, City of Scottsdale	MAG	ADOT TOC	ADOT TOC	ADOT TOC	Function 14 (freeway-arterial operations)
Emergency Vehicle Signal Preemption Group Initiative Champion: Jan Siedler, City of Mesa, and Jim Decker, City of Tempe	LTMCs	LTMCs	LTMCs	LTMCs	Function 19 (standards for emergency vehicle signal preemption)

* Local Traffic Management Centers

Table 4-4 – Summary of Agency Responsibilities (continued)

Oversight and Scoping	Involved Agencies				Associated Function
	Planning	Implementation	Operations	Maintenance	
Transit Signal Priority Group Initiative Champion: Bob Ciotti, Valley Metro, and Jim Decker, City of Tempe	Valley Metro MAG	Valley Metro	Valley Metro	Valley Metro	Function 20 (Transit Signal Priority)
Center-to-Center Communications Group Initiative Champion: Tim Wolfe, and Carl Burkhalter, ADOT TOC	MAG	ADOT TOC	ADOT TOC	ADOT TOC	Function 25 (center-to-center communications)
Archived Data Group Initiative Champion: Dave Wolfson, MCDOT	MAG	MCDOT	ADOT TOC	ADOT TOC	Function 26 (data archiving system)
LTMC/TOC Operators Group Initiative Champion: Tim Wolfe and Linda Anestasi, ADOT TOC	LTMCs ADOT TOC	LTMCs ADOT TOC	LTMCs ADOT TOC	LTMCs ADOT TOC	Function 27 (after-hours signal system monitoring)
	ADOT TOC	ADOT TOC	ADOT TOC	ADOT TOC	Function 28 (inter-agency notification)
Travel Information Group Initiative Champion: Faisal Saleem, MCDOT	LTMCs	LTMCs	LTMCs	LTMCs	Function 29 (local information to HCRS and/or 511)
	Valley Metro	Valley Metro	Valley Metro	Valley Metro	Function 30 (transit information to 511)
	LTMCs	LTMCs	LTMCs	LTMCs	Function 31 (arterial detection)
	LTMCs ADOT TOC	LTMCs ADOT TOC	LTMCs ADOT TOC	LTMCs ADOT TOC	Function 32 (post travel information/messages)
	ADOT TOC	ADOT TOC	ADOT TOC	ADOT TOC	Function 33 (market travel information)
The following functions do not require institutional arrangements but require regional coordination	ADOT TOC	ADOT TOC	ADOT TOC	ADOT TOC	Function 1 (ramp metering operations)
	ADOT TOC	ADOT TOC	ADOT TOC	ADOT TOC	Function 8 (ADOT ALERT/FSP operations)
	Valley Metro	Valley Metro	Valley Metro	Valley Metro	Function 16 (transit notification of incidents)

4.5 Recommended Institutional Framework for the MAG Region

It is not the intent of the Regional Concept of Transportation Operations to create new groups or organizations.

Rather, in consultation with each of the *initiative champions*, functions identified in the *Function Summary sheets* have been assigned to existing groups and organizations. The following discussion summarizes each of the initiatives, and identifies short-term milestones that will be accomplished within the next 6 to 12 months. It is anticipated that accomplishment of the intermediate milestones will help to achieve the 3-year and 5-year goals.

4.5.1 Regional Traffic Signal Optimization Program

A key objective of the Regional Concept of Transportation Operations is to improve traffic signal timing both within cities and across jurisdiction boundaries. The Champion for improved the Regional Traffic Signal Optimization Program will be Mike Mah, City of Chandler. Specifically, he will champion the following:

- Development of a pre-set signal timing structure to improve traffic flow during incidents (Function 18);
- Regular and consistent review of signal timing plans within cities, and update of necessary (Function 2); and
- Signal timing of cross-border traffic signals (Function 3).

It is anticipated that specific activities associated with improved regional traffic engineering collaboration may include:

- Identification of priority network areas for timing assessment;
- Facilitation of inter-agency collaboration for signal timing optimization;
- Identification and separation of cross-border traffic signals into control section groups, and modification of the control groupings when necessary;
- Ensuring a common understanding of signal timing operating strategies between agencies; and
- Improving communication between adjacent agencies prior to making signal timing changes on corridors that cross jurisdictional boundaries.

The Champion (Mike Mah) will work to ensure that the above issues are addressed as needed during meetings of the MAG ITS Committee and the AZTech™ East Valley and West Valley Signal Timing Groups, and/or separate/specific meetings.

Specific details of the signal timing plans may be addressed by the East Valley and West Valley Traffic Signal Timing Groups, and informally between agencies as required.

Allocation of Resources: The MAG ITS Committee will be responsible for formally allocating resources (funding) for the Regional Traffic Engineering Collaboration functions. Funding is currently available through the MAG ITS On-Call contracts ($300,000 for two years). Future funding should be allocated through the MAG TIP. It is expected that local agencies also will contribute staff time, as needed, to review traffic signal timing plans developed by the assigned consultant.

Intermediate Milestones: The following steps are proposed to be accomplished within the next six months.

1. A map of each agency's traffic signals will be complied into a regional map. This will facilitate the identification of traffic signal control groups.
2. Information about each traffic signal will be obtained. This information may include, but is not limited to:
    a. How many signals in the jurisdiction
    b. How each agency/city separates their traffic signals into networks
    c. What timing plans are being run on each signal, and the hours of operation

Upon completion of the first two steps outlined above, Mike Mah will coordinate with the East Valley and West Valley Traffic Signal Timing Groups to identify specific networks and corridors that should be retimed. The identified networks will be approved through the MAG ITS Committee, and the appropriate consultant contracts will be managed by MAG. Mike Mah and the East Valley and West Valley Traffic Signal Timing Groups will continue to provide technical guidance to the consultants.

4.5.2 Arterial and Freeway Incident Management

The Regional Concept of Transportation Operations identified a need for improved incident management collaboration between fire and public safety, and transportation departments. Incident management can be separated into freeway incident management, and arterial incident management.

Freeway Incident Management

Improved freeway incident management collaboration will be achieved through the ADOT/DPS/Governor's Office of Highway Safety (GOHS) Partnering Group, and will be championed by Tim Wolfe, ADOT TOC.

Improved arterial incident management collaboration will be achieved through the AZTech™ Incident Management Working Group, and will be championed by Faisal Saleem, MCDOT.

The ADOT/DPS/GOHS Partnering will work to:

- Improve agency-specific incident management practices that will result in reduced incident clearance times (function 4);
- Schedule and participate in incident debriefing sessions after large incidents with representatives of public safety (DPS, sheriff, police departments), fire departments, and applicable local transportation agencies (function 5);
- Improve the pre-qualified list of towing and recovery vehicles (function 9);
- Facilitate agreements between agencies for the extraction of computer-aided-dispatch (CAD) information to travel information services and ADOT TOC (function 11);
- Facilitate improvement of practices for on-scene coordination and communication (function 12); and
- Facilitate improvement of practices for placement of emergency vehicles at incident scenes (function 13).

Specific intermediate milestones (6 months and 12 months) will be decided upon by the ADOT/DPS/Governor's Office of Highway Safety Executive Partnering Group.

Arterial Incident Management

Arterial Incident Management will be championed by Faisal Saleem and Barbara Hauser, both of MCDOT. They will champion the following through the AZTech™ Incident Management Working Group:

- Develop, implement, and maintain a region-wide Arterial Incident Management Program, based on results of feasibility study and pilot project (function 15); and
- Facilitate agreements between agencies for extraction of CAD information to local traffic management centers (function 25).

Intermediate Goal: The following intermediate goals will be accomplished within the next 6 to 12 months:

- Complete inter-governmental agreements for two additional cities; and
- Plan for a demonstration project for extraction of CAD information from local public safety to local traffic management center.

4.5.3 Shared Maintenance and Resources

The sharing of maintenance resources, staff, and equipment can result in improved system performance and significant cost savings. The sharing of maintenance and resources will be championed by Tim Wolfe, ADOT TOC and Darrell Bingham, ADOT TOC. Specifically, they will champion:

- Improving the preventive maintenance and prompt repair of locally owned ITS field devices and central systems (function 21);
- Improving the preventive maintenance and prompt repair of regionally significant ITS field devices and central systems (function 22);
- Maintenance of regional communication infrastructure (function 23); and
- Developing cost sharing agreements between agencies (function 24).

The above functions will be championed through the AZTech™ Traffic Operations Working Group.

Resource Allocation: It is anticipated that funding for maintenance of systems will largely be derived from existing agency maintenance budgets; however, cost-sharing agreements will result in greater efficiencies in maintenance activities, resulting in improved system performance. Additional funding may also be available through the Federal Surface Transportation Reauthorization Act, TEA-3 (dependent upon rules and restrictions contained within the Act) or the half-cent sales tax (pending passage).

Intermediate Goal: The Shared Maintenance and Resources Champions will work with the AZTech™ Traffic Operations Working Group to develop six month milestones.

4.5.4 Freeway-Arterial Operations

The Regional Concept of Transportation Operations identified a need for improved freeway-arterial corridor operations. Bruce Dressel, City of Scottsdale, will champion

improved freeway-arterial operations through the AZTech™ Technical Oversight/Traffic Operations Working Group.

Specifically, the AZTech™ Technical Oversight/Traffic Operations Working Group will work to plan, deploy, operate, and maintain a research freeway-arterial corridor operations pilot project (function 14).

Resource Allocation: It is recommended that the Freeway-Arterial Operations Pilot Project be funded through the MAG TIP, provided that this is consistent with regulations in the next Federal Surface Transportation Reauthorization Act (TEA-3). Alternatively, funding could be available through the half-cent sales tax, pending election results in 2004.

After deployment of integrated freeway-arterial operations, it is recommended that continued operations and maintenance of the integrated systems be the responsibility of the local jurisdiction, in conjunction with local signal systems operations and maintenance.

Intermediate Goal: Within the next 12 months, policies will be developed that govern freeway-arterial operations. For example, Level-of-Service thresholds, indicating the level of back-up and queue lengths at freeway on-ramps will be developed that are acceptable to both ADOT and the local municipalities. Practices will be outlined that dictate mitigating actions when freeway-arterial conflicts occur (e.g., flush ramps, restrict interchange green-time).

4.5.5 Emergency Vehicle Signal Preemption

The Regional Concept of Transportation Operations identified a need for a common set of standards for the implementation of emergency vehicle signal preemption systems (function 19).

Jan Siedler, City of Mesa, and Jim Decker, City of Tempe, will champion the development of emergency vehicle signal preemption standards.

It is anticipated that work already completed by City of Mesa staff will serve as the foundation for a regional standard.

The AZTech™ Technical Oversight/Traffic Operations Working Group will provide the regional forum for decision-making and collaboration in order to achieve consensus on the standards for emergency vehicle signal preemption.

Resource Allocation: It is anticipated that development of the standard can be achieved by local agency staff. If necessary, development of a EVSP standard could be a consultant assignment in the MAG ITS on-call.

Intermediate Goals: It is proposed that the following goals be accomplished within the next six months:

- Fully catalog the standards that have been largely decided upon, but have not been documented (e.g., distance to preempt, pedestrian phasing, left-turn phasing);
- Educate those agencies that haven't yet selected a emergency vehicle signal preemption system as to the major issues that should be considered before selecting a specific vendor; and
- Implement a test-run of emergency vehicles equipped with multiple strobes (from different vendors, e.g., 3M and Tomar).

4.5.6 Transit Signal Priority

The Regional Concept of Transportation Operations set a goal of deploying a transit signal priority corridor within the next 3 years. Bob Ciotti, Valley Metro, and Jim Decker, City of Tempe will champion the implementation and evaluation of a transit signal priority pilot project (function 20), in conjunction with the AZTech™ Traffic Operations Working Group**.**

Intermediate Goal: The City of Tempe, in cooperation with the University of Arizona, is currently planning a transit signal priority deployment. Work on this project will continue.

4.5.7 Center-to-Center Communications

The Regional Concept of Transportation Operations set a goal of establishing center-to-center communications between 15 agencies within the next 3 years. Implementation of center-to-center communications (function 25) will be championed by Tim Wolfe and Carl Burkhalter, ADOT TOC, through the AZTech™ Traffic Operations Working Group.

Resource Allocation: It is anticipated that a significant portion of funding for center-to-center communications will be allocated through the MAG TIP, and the half-cent sales tax (pending passage).

Intermediate Goal: Intermediate goals will be decided upon in consultation with the AZTech™ Traffic Operations Working Group.

4.5.8 Archived Data

Data Archiving (function 26) will be championed by Dave Wolfson, MCDOT, through the MAG ITS Committee. It is anticipated that the Regional Archived Data System (RADS) will be functional within the next few months.

Specific milestones will be established upon consultation with Dave Wolfson (unavailable at time of publication).

4.5.9 LTMC/TMC Operators

Improved coordination and communication between TMC operators is a goal of the Regional Concept of Transportation Operations. Specifically, the RCTO identified the need for:

- Development and maintenance of a comprehensive personnel and logistics resource list (function 7);
- Developing practices for after-hours monitoring of local traffic management center systems and devices (function 27); and
- Improving inter-agency communication between TMCs during incidents (function 28).

Tim Wolfe, ADOT TOC and Linda Anestasi, ADOT TOC will champion these functions through the AZTech™ TMC Operators Group.

Allocation of Resources: Many of the local TMCs do not have dedicated staff. Additional staff may need to be hired and trained in order to improve collaboration between TMCs. In addition, software may need to be developed that provides integration capability between the TMCs to enable the after-hours monitoring of signal systems and field devices.

Potential funding sources for implementation of the above functions are local city budgets, pooled-city funding, or the development of projects for additional TMC operators through the MAG TIP process. Additional funding arrangements and sources and arrangements will be explored by the TMC operators group, and the AZTech™ Traffic Operations Working Group.

Intermediate Goal: Intermediate goals will be established in consultation with the AZTech™ Traffic Management Centers Operators Group.

4.5.10 Travel Information

Provision of travel information in the MAG Region will be championed by Faisal Saleem, MCDOT through the AZTech™ Travel Information Group.

Specifically, Faisal Saleem will champion:

- Make available work zone, incident and transit information to HCRS and/or 511 (function 29);
- Integrate transit information with travel information services (e.g.., Provide AVL data to 511) (function 30);
- Develop practices for collecting information from arterial detectors (function 31);
- Post travel information/messages on freeway and arterial VMS (function 32); and
- Market travel information services (function 33).

Resource Allocation: It is anticipated that a significant portion of funding for provision of travel information will be allocated through the MAG TIP, and the half-cent sales tax (pending passage). The AZTech™ organization will also continue to pursue federal grants.

Intermediate Goals: Intermediate goals for each function are as follows:

- Providing work zone, incident and transit information to HCRS and/or 511 (function 29): The 6-month goals are to deploy HCRS in 4 jurisdictions, and to ensure that they are functional and operational;
- Integrate transit information with travel information services (e.g. Provide AVL data to 511) (function 30) – To be determined;
- Develop practices for collecting information from arterial detectors (function 31): The 6-month goals are to begin to utilize existing detection, and ensure that data from existing detection devices is available for dissemination;
- Post travel information/messages on freeway and arterial VMS (function 32): The 6-month goal is to complete the City of Phoenix Variable Message Sign demonstration project, and to extract lessons learned for future application; and
- Market travel information services (function 33): The 6-month goals are to complete the development of the 511 Outreach and Marketing Plan, and to fully organize the AZTech™ ATIS Committee.

4.5.11 Performance Measurement

MAG will manage and conduct performance measurement, as outlined in Tech Memo No. 4: Goals and Performance Measures.

Allocation of Resources: Performance measurement will be funded by MAG.

Intermediate Goals: The intermediate goals to be accomplished within the next 6 to 12 months are to plan, develop and implement a web-based performance measurement and reporting program.

The following figure summarizes the proposed institutional framework for implementation of the Regional Concept of Transportation Operations.

Regional Concept of Transportation Operations: Oversight and Scoping Framework

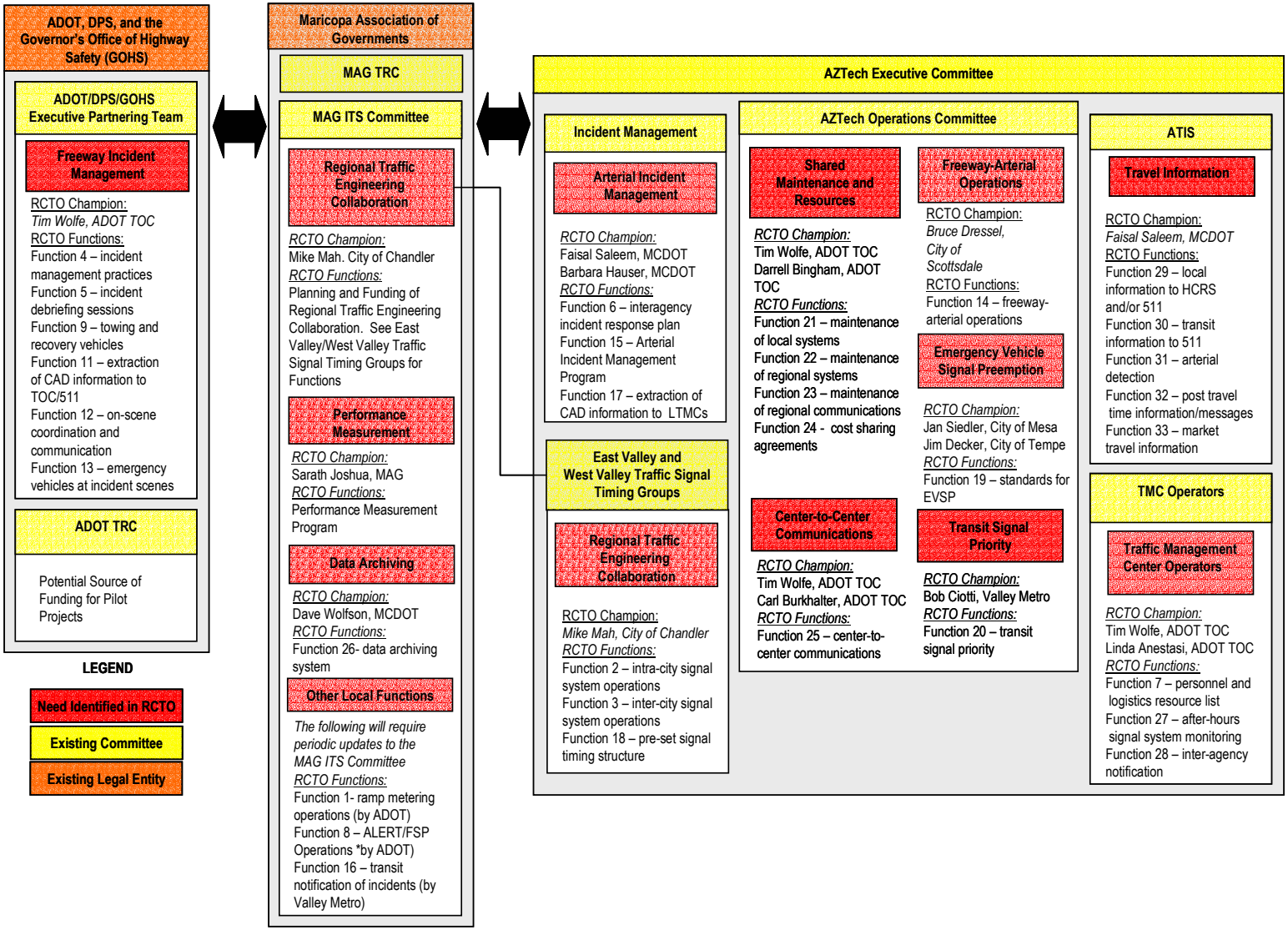

Figure 4-2 – Proposed Institutional framework for transportation operations in the MAG Region

5. STAFFING REQUIREMENTS FOR LOCAL AND REGIONAL AGENCIES FOR THE OPERATIONS AND MAINTENANCE OF ITS

Operations and maintenance (O&M) staffing is necessary to achieve the full potential of Intelligent Transportation Systems. In essence, a good system plus sufficient well-trained O&M staff equals good operations. To attain full system potential, agencies should consider the O&M staff as much a part of the system as the hardware and software itself.

Traditionally, agencies use their own staff to carry out O&M activities. As pressure to minimize the number of staff positions mounts, many agencies may not have sufficient staff to operate and maintain systems that are expanding to include ITS elements. With a lack of available and qualified staff, agencies could combine regional resources through inter-jurisdictional maintenance agreements or use private contractors for some or all of their O&M activities.

5.1 Considerations and Influences

There should be different considerations given to staffing more traditional traffic signal systems than to newer ITS devices, especially ITS components within an arterial environment. Traffic signal systems have been operated and maintained by agencies of various sizes for many years. There is a significant body of knowledge and experience regarding staffing levels for signal systems. The major challenges in extending this experience to current O&M needs are:

- Finding information documenting the knowledge and experience in staffing traffic signal systems because very little has been written, especially on a national or comparative level;
- Making comparisons with organizations that have similar equipment, organizational structures, position responsibilities, and goals and priorities for their signal systems; and
- Identifying information or resources required for O&M of other ITS, which have been more recently implemented.

Available information has been supplemented with interviews with other agencies. A further challenge involves drawing conclusions from these comparisons because of differences in position responsibilities, organizational structure, and organizational priorities. The Institute of Transportation Engineers (ITE) document, *Traffic Control System Operations – Installation, Management, and Maintenance*, is a useful resource for analyzing staffing needs for maintaining and operating traffic signal systems.

When considering staffing to maintain and operate ITS systems there is a lack of national experience, especially in the arterial environment. While there are no published standards that set forth the minimum (or even suggested) number of personnel and their responsibilities needed to operate and maintain ITS devices, there have been a number of professional papers and articles published on the topic, especially for freeway environments. Furthermore, professional organizations such as ITE have convened workshops and issued white papers that typically include some high-level recommendations on the topic. The ITE publication, *Recommended Practices for Operations and Management of Intelligent Transportation Systems*, offers useful insight in staffing to operate and maintain ITS.

For signal systems and ITS elements, considerations (or influences) in decision-making include:

- **Technologies and implementation** used in the systems to be operated and maintained. Some technologies are easier to operate or maintain than others; however, there can be differences in equipment, skills, or training needed to operate or maintain them. For

example, fiber optic communication systems might require less maintenance than copper systems; however, someone trained and equipped to make splices on a coaxial system will need different equipment, and may not have the skills, to splice fiber systems. The specific implementation of the given system also can affect the staffing levels needed to operate or maintain the system. For example, fiber systems can be implemented with sophisticated fiber plant management systems that automatically detect errors in transmission or breaks in fiber and can alert O&M staff about potential problems, while automatically re-routing communication traffic.

- **Policies and emphasis areas**. An agency's policies regarding customer service, preventive maintenance, and staffing can directly affect appropriate staffing levels. As agencies strive for improved customer responsiveness and reduced time to correct problems identified by customers, additional staffing is needed if the public investment in signal systems and ITS is to be protected through preventive maintenance.

- **Staffing approaches and staff responsibilities**. There are several approaches to providing O&M staffing. In-house staffing, outsourcing, and facilities management approaches will be discussed later in this section. Staffing levels are dependent on the approach. Fewer agency staff are required if services are contracted out than if all of the work is kept in-house; however, knowledgeable staff that can direct and manage the contractors still will be needed. Staff responsibilities also will affect the number of staff needed. Organizations group responsibilities differently; some provide separate crews to maintain signal systems than to construct, improve, or rehabilitate signal systems, and other organizations include streetlight maintenance and signal maintenance in the same crew. Many other models are possible; however, each of these will affect the number of staff needed to maintain signals. Detailed staff descriptions, functions, responsibilities, and qualifications can be referenced in the *MAG ITS Strategic Plan Update, Technical Memorandum No. 9*, prepared by Kimley-Horn and Associates, Inc.

- **Anticipated/planned growth in devices**. As an agency's inventory of ITS devices increases, it is expected that the number of maintenance staff also will increase. For example, the City of Seattle is planning for significant increases in numbers of ITS devices. They currently maintain 90 ITS devices and project that the number will increase to 424 devices in three years. They have been successful at keeping the number of failures stable by adding staff as inventory of devices has increased; however, the rapid increase in ITS devices is a concern.

5.2 Staffing Levels – Maintenance

In general terms, classifications for maintenance positions and their responsibilities include traffic signal personnel and ITS field hardware maintenance personnel. The following classification descriptions are from ITE's *Traffic Control System Operations – Installation, Management, and Maintenance*.

5.2.1 Traffic Signal Personnel

Personnel required for the maintenance of traffic signal and control equipment can be classified into five categories based on responsibilities, knowledge, and skills.

Traffic signal mechanic: responsible for diagnostic maintenance up to the device exchange level in the field, including complete responsibility for the operation of electromechanical controllers; capable of diagnosing a failure, initiating corrective action, and performing preventive maintenance on the signal heads and suspension gear (e.g., cleaning of the lens and replacement of lamps).

Supervising traffic signal mechanic: includes responsibilities described for a signal mechanic; responsible for scheduling and recording work performed by the other signal mechanics in the group; preparing quantity and cost estimates for the annual budget.

Traffic signal technician: responsible for maintaining solid state equipment in the field as well as identifying failures at an intersection; assists the traffic signal engineer in troubleshooting, testing incoming equipment, and setting controller timing as specified by the traffic engineer.

Traffic signal engineer: requires extensive training and troubleshooting skills in electronics firmware and software, as well as a thorough knowledge of theory of operations of the equipment; responsible for the diagnostics and repair of all solid state controllers to the chip level; makes field trips to aid the traffic signal technician in returning the equipment to normal operation, and, if unable to identify the problem, requests factory assistance.

Traffic engineer: responsible for traffic signal design, design modifications, signal timing plans, and administration of signal installation and maintenance.

(Authors' note from *Recommended Practices for Operations and Management of Intelligent Transportation Systems*: With the lack of the electromechanical manufacturers' support of supplying replacement parts, the high cost of labor, the yearly preventive maintenance, repair, and the availability of low-cost, highly reliable solid state controllers, the positions of traffic signal and supervising traffic signal mechanics will soon be extinct.)

5.2.2 ITS Personnel – Field Hardware

Personnel required for maintenance of ITS field hardware can be classified into categories based on responsibilities.

Technician: A technician is responsible for maintaining the ITS hardware equipment in the field as well as identifying failures at specific surveillance and control devices. He or she assists the electronics technician in troubleshooting, testing incoming equipment, and setting traffic controllers as specified by the system operator.

Electronics technician: This person is responsible for diagnostic maintenance up to the device exchange level in the field, including complete responsibility for the operation of the traffic controllers, communication modems, and/or multiplexers. He or she is capable of diagnosing a failure, initiating corrective action, and performing preventive maintenance on the field electronics.

Electronics supervising technician: In addition to the responsibilities described for technicians and electronics technicians, a supervisor also is responsible for scheduling and recording work performed by the technicians in the group and for preparing quantity and cost estimates for the annual budget.

5.2.3 National Experience

The experience of other agencies is documented below under the categories of traffic signal systems, ITS devices, and communications system.

Traffic Signal Systems. In order to keep traffic signal systems operational and operating safely and efficiently, it is essential to perform preventive maintenance. Personnel used for maintenance actions for freeway and traffic signal systems have similar backgrounds and experience. This tendency has emerged in recent years as these two types of traffic systems have increasingly used the same devices. Each of these system types requires management and field personnel.

Many agencies develop a preventive maintenance plan that allows for personnel to determine if all equipment is properly operating and take steps to help it operate properly until the next preventive maintenance visit. The plan usually includes requirements for maintenance staffing.

There is no formula for determining staff size and composition for maintenance actions. Each system is unique and requires a study of staffing needs. A general rule that appears to be popular in the profession is to assume one traffic signal technician can effectively maintain 40-50 traffic signals. (The International Municipal Signal Association (IMSA) recommends 30 to 35 signals per technician.) Recent studies have confirmed that these guidelines can be considered reasonable. The following information is contained in the ITE *Traffic Control System Operations* and an issues paper for the Florida Statewide ITS Strategic Plan.

- A survey of 23 cities, similar in size to Hampton, Virginia (population 141,000), was conducted for the City of Hampton as part of their traffic signal system upgrade project. The survey found an average of one traffic engineer per 76 traffic signals and one traffic signal technician per 47.1 traffic signals.
- A National Cooperative Highway Research Program (NCHRP) survey found that a single maintenance person could maintain 38-43 traffic signals.
- The City of Menlo Park, California recommends one traffic signal technician for every 50 traffic signals and one traffic signal engineer for every 100 traffic signals to ensure adequate O&M of their traffic signal system.
- In the Phoenix, Arizona metropolitan area, number of signals per technician varies by agency, but the range is from 22 signals per maintenance staff member to 44 signals per maintenance staff member (includes technicians, supervisors, and administration positions). Most agencies employ about one maintenance staff person per 30 traffic signals.
- The City of Albuquerque has about one maintenance employee for every 60 signalized intersections.
- In the Northwest Region of the Washington State Department of Transportation (WSDOT), the region that includes the Seattle-Everett urban area, traffic signal maintenance is divided between electronic components and power/electrical components. Six electronics technicians maintain 430 signal controllers and cabinets. (In addition, ten two-person teams maintain the power and electrical components of the 430 signals plus 300 flashing beacons and 22,000 street lights.) The signal maintenance managers indicate that the corresponding 70+ signals per electronics technician is too high and that they prefer a ratio of 40 to 45 signals per electronics technician. (Their situation is exacerbated because of the distances that the technicians travel. Although they are housed in three different locations, they maintain signals from the Canadian

border to about 20 miles south of downtown Seattle and from Puget Sound to the Cascade Mountains.)

- The City of Seattle has 983 traffic signals and 90 ITS devices that they maintain with 16 signal electricians, for an average of just over 61 signals per maintenance technician.

Table 5-1, below, summarizes these findings.

Table 5-1 – Summary of Number of Traffic Signals per Technician

Agency	Amount	Description
General rule (ITE)	40-50	traffic signals per signal technician
IMSA	30-35	traffic signals per signal technician
Hampton study	47	traffic signals per signal technician
NCHRP	38-43	traffic signals per signal technician
Menlo Park	50	traffic signals per signal technician
Menlo Park	100	traffic signals per signal engineer
City of Phoenix	22-44	traffic signals per signal technician
Phoenix metropolitan area	30	traffic signals per signal technician
Albuquerque	60	traffic signals per signal technician
Northwest Region – existing	70+	traffic signals per signal technician
Northwest Region – desired	40-45	traffic signals per signal technician
Seattle – existing	61	traffic signals per signal technician
Proposed Guideline	***50***	***traffic signals per technician***

ITS Devices. There are no established, accepted guidelines that agencies can utilize to determine maintenance staffing levels by classification for the number and type of ITS devices that it owns and operates; however, there are several agencies that maintain ITS devices that have staffing levels and/or practices that can be found in literature or have been interviewed for this project.

- The Oregon Department of Transportation's (ODOT's) Statewide ITS Maintenance Plan establishes guidelines based on experience within the department and discussions with equipment vendors; however, these guidelines have yet to be tested in practice. (One of the recommendations from that study is to implement these guidelines on a test basis.) The plan identifies about 1,750 ITS devices, ranging from emergency signal preemption systems to CCTV cameras and road weather information systems. The plan identifies the need for eight positions to maintain this inventory.
- The Maryland State Highway Agency (SHA) employs eight technicians to conduct both response and limited preventive maintenance for 35 permanent and close to 100 portable VMS. Maryland SHA has another 11 technicians that are responsible for both response and limited preventive maintenance for 250 field devices including CCTV cameras, road weather information systems, detectors, and traveler advisory radio units.
- Virginia Department of Transportation's (VDOT's) Northern Virginia Advanced Traffic Management System (ATMS) employs seven technicians and one engineer on a

full time basis to conduct response maintenance for over 1500 devices, including CCTV cameras, VMS, and detectors. They seldom conduct preventive maintenance.

- In WSDOT's Northwest Region, there about 1150 ITS devices from CCTV cameras and call boxes to ramp meter systems. The WSDOT also maintains over 100 miles of fiber optic cable system. There is 12 maintenance staff to conduct both response and preventive maintenance for these devices.

These examples indicate that one maintenance staff person can maintain anywhere from 100 to 200 ITS devices, the lower number for less complicated devices and the higher number for more complicated devices.

Choice of technology can affect the size of the required maintenance staff. For example, over time some agencies have retained portable VMS after the completion of construction projects. As all projects tend to have different specifications, geographic, and contractual constraints and opportunities, agencies end up with a wide variety of different technologies that comprise their portable VMS fleet, thus complicating maintenance activities. Developing an agency-wide specification can mitigate this type of problem.

Table 5-2 – Summary of ITS Devices per Electrician

Agency	Description			
ODOT	8	positions for	1750	devices
	219	***ITS devices per technician***		
Maryland SHA	8	technicians for	135	portable/permanent VMS
and	**17**	***ITS devices per technician***		
Maryland SHA	11	technicians for	250	CCTV, RWIS, detectors, and traveler advisory radio units
	23	***ITS devices per technician***		
Virginia	7	technicians for	1500	devices
	1	engineer		
	214	***ITS devices per technician***		
WSDOT's NW Region	12	technicians for	1150	devices
			100	miles of FO cable system
	96	***ITS devices per technician***		
Results – more complicated	1	technicians for	100	devices
Results – less complicated	1	technicians for	200	devices
Guideline	***100***	***ITS devices per technician***		

Communication Systems. Communications maintenance often is outsourced, as most agencies do not possess the required expertise in-house to perform the maintenance activities. Requirements of communications technicians tend to include an in-depth knowledge of O&M of fiber optic cable, radio, microwave, voice, spread-spectrum, and landline technologies.

Technology choices also can reduce the overall need for maintenance activities. Fiber management systems can automatically diagnose problems and even re-route

communications in case of a fiber break. These systems not only fulfill some aspects of preventive maintenance by remotely testing system components, but also reduce the need for emergency call-outs by re-routing communication signals.

- As noted above, WSDOT maintains its fiber system in-house, although it maintains a contract for a company to supply certain services, such as fiber splicing. Because of the way in which WSDOT combines maintenance responsibilities, they have not specifically allocated resources solely to maintaining their fiber network.
- The ODOT plan estimates that they will only need 0.2 full time equivalent (FTE) positions for its 80-mile fiber optic system, indicating one maintenance staff person can maintain 400 miles of fiber optic system.

This high ratio of miles of communication fiber and the corresponding equipment to maintenance staff ratio is an indication of the reliability built into modern fiber systems. Fiber systems also can include in-line diagnostic equipment to pinpoint faults when they do occur. Fiber system electronics usually provide redundant paths so backbone communication is not interrupted if there is a fault or break in the cable. Response maintenance should be low for fiber systems. Thus, a staffing guideline of **one maintenance staff person per 400 miles of communication fiber** is recommended.

5.2.4 Recommended Staffing Guidelines

A staffing guideline of **50 traffic signals per technician** is recommended for each agency's Signal Maintenance section. It should be noted that there is some variation in the number of traffic signals per maintenance staff member reported from agencies, the classifications included in the ratios, and the responsibilities of those classifications. In addition, for every four electricians, there should be one maintenance worker. Thus, a staffing guideline of **0.25 maintenance workers per technician** is recommended for each agency's Signal Maintenance section.

A recommended ratio of ITS devices per maintenance staff member is challenging to determine. The variations mentioned above are exacerbated by the variation in types of ITS device; however, the range was generally between 100 and 200 devices per maintenance staff. Because most of the agencies in the MAG region are either early in their deployment of ITS devices or have recently deployed ITS devices, a ratio of **100 ITS devices per technician** is recommended initially, allowing the ratio to expand higher as technicians gain experience and comfort with the devices.

Finally, the best reference found on maintenance staffing for fiber systems was the ODOT maintenance plan. The plan indicates that 80 miles of fiber requires 0.2 full time equivalent staff persons. This relates to a ratio of **400 miles per technician**.

Table 5-3 presents these recommended staffing guidelines and the resulting staffing needs for each agency's current inventory of traffic signals and ITS devices. Fiber system maintenance staffing recommendations are not included in the table due to insufficient inventory data.

Table 5-3 – Recommended Staffing Guidelines for Agencies' Current Inventory

Description	ADOT	Chandler	Gilbert	Glendale	Goodyear	Mesa	MCDOT	Peoria	Phoenix	Scottsdale	Surprise	Tempe
Current Inventory Traffic Signals	156	80	50	146	20	293	125	69	877	263	10	174
Recommended Staffing – Electrician	3.90	1.6	1.0	2.92	0.4	5.86	2.5	1.38	17.54	5.26	0.2	3.48
Recommended Staffing – Maintenance Tech.	0.78	0.4	0.25	0.73	0.1	1.47	0.63	0.35	4.39	1.32	0.05	0.87
Total Traffic Signal Maintenance Staff	*4.68*	*2.0*	*1.25*	*3.65*	*0.5*	*7.33*	*3.13*	*1.73*	*21.9*	*6.58*	*0.25*	*4.35*
Current Inventory: ITS Devices	567	2	1	2	4	10	2	0	12	40	0	3
Total ITS Devices Maintenance Staff	*5.67*	*0.02*	*0.01*	*0.02*	*0.04*	*0.1*	*0.02*	*0*	*0.12*	*0.4*	*0*	*0.03*
Total Required Maintenance Staff	**10.35**	**2.02**	**1.26**	**3.67**	**0.54**	**7.43**	**3.15**	**1.73**	**22.05**	**6.98**	**0.25**	**4.38**

5.3 Staffing Levels – Operations

Operations positions are not as uniform nationally and not as easy to define as maintenance positions. Operations staffing depends on system specific elements as well as system specific requirements that flow out of the system's objectives and emphasis areas.

5.3.1 Operational Requirements

Each system has a particular set of operational requirements that reflect the agency's goals and objectives for the system. The operational requirements will drive the specific staffing needs for the system. Operational requirements should be defined when the system is first designed and should be updated and modified as conditions change throughout the life of the system.

Operational requirements will drive specific functions included in the system. Some examples of typical functions for an arterial management system include:

- Traffic signals and traffic control;
- Traffic and system monitoring;
- Special event management;

- Incident management;
- Coordination and collaboration with other agencies; and
- Traveler Information gathering and dissemination.

Operational requirements can only be met by a staff of appropriately-trained individuals who have specific knowledge and experience necessary to perform the specific functions.

5.3.2 ITS Personnel – Operations Center

Arterial systems have different requirements than those focusing on freeways. Most of the existing literature on traffic operations center staffing is based on freeway management or regional traffic management centers; however, there are some positions that can be described in general terms for any ITS traffic operations center. Not all of these positions and responsibilities are appropriate for every system, but many are necessary for successful operation of a traffic operations center.

ITS operational functions are not as clearly defined as those for traffic signal control systems. Some of the functional level descriptions for ITS operations include the list below. There usually is not one position dedicated to each of these functions, but the functions often need to be addressed by staff. These ITS specific positions have been taken from requirements listed in the NCHRP 20-5 *Transportation Management Center Functions* report and ITE *Traffic Control System Operations: Installation, Management, and Maintenance*. The general positions and their responsibilities include:

Traffic Signal Engineer or Engineering Technician: Responsible for adjusting traffic signal system timing parameters. Signal timing plans age with time, so it is necessary to update parameters in order to adjust to current conditions. He or she needs training in basic traffic engineering and controller and system specific parameters and operations. If the person is responsible for operating a coordinated system, additional training is needed in using computer programs to optimize flow on a system of traffic signals.

As mentioned previously, the City of Menlo Park, California recommends one traffic signal engineer for every 100 traffic signals to ensure adequate operations of their traffic signal system.

Program Management and Development: Engineer, plan, and develop projects that support ITS operations. These staff also develop and maintain the ITS concept of operations that the systems support. These staff members develop the necessary inter-agency agreements and provide liaison between agencies. They also monitor system performance and modify operational strategies as needed to maximize user services. Program management/development staff will identify needs for new ITS services or technologies for inclusion in the work program.

Information Service Provider (ISP) Facilitator: Staff to register and administer private sector participation in travel information services.

ISP Technical Support: Engineers and technicians to provide the information services and connections to registered ISPs, including video and data feeds.

Website Development/Support: Programmers and graphic artists to provide website administration, development and technical support.

Outreach: Public information specialists to promote and market the ITS and travel information services that have been developed. This staff also provides outreach and support for ITS related public/private partnerships.

Control Center Technician: This is an electronics technician who may be junior to the communications specialists but nevertheless has been trained in the maintenance of digital electronic equipment, particularly microprocessors. This person can identify hardware failure and make repair/replace decisions. The position requires considerable troubleshooting skills as well as the ability to perform all types of testing.

Communications Technician: This position requires an electronics technician who is trained in the operations of a variety of wireline, wireless technologies, and radio communications systems supporting video, data, and voice transmissions. In any ITS system a high percentage of the capital cost is invested in communications. It only makes sense to protect this investment by providing a quality level of maintenance. As communications hardware evolves, it becomes almost a constant situation where one subsystem or another is always being upgraded and/or replaced.

System Administrator: Responsible for user access management, communications configuration, configuration management, upgrades to the system and off-the-shelf-software, testing, installation, responding to user trouble reports, and supporting remote users.

System Operator: Responsible for operating the system, notifying emergency response agencies, system maintenance staff, and other outside agencies and organizations. The system operator must be computer literate and capable of performing many computer-related skills. Most ITS operating centers are actually composites of several different subsystems, so the system operator must be familiar with the operating commands of several different systems. A typical combination could include Highway Advisory Radio (HAR), dynamic message signs (DMS), and ramp metering, as well as a CCTV surveillance system. Each of these subsystems may have a different operator interface, and the system operators must be fully trained on all of the systems.

Database Manager: Responsible for database management system operations, adjusting the configuration as required, installing upgrades, and overseeing administrative tasks.

Configuration Manager: Responsible for documenting, tracking, testing, and maintaining software versions during the active development of software upgrades or installations.

Software Programmer: This level of programming skill would require proficiency in the database management programming languages, geographic information systems (GIS) and computer aided design and drafting (CADD) software packages, and firmware for traffic signal controllers. Generally, the real-time system software is maintained by a contractor.

Shift Supervisor/Manager: This position is frequently filled by a person who came up through the ranks and achieved competence through a blend of job-related training and personal experience. The supervisor must have a well-developed judgmental skill that allows him/her to distinguish between situations that can be handled within the resources of the traffic operations center and those that require the participation of one or more sister agencies. This person is responsible for the development of the operating plan, including the magnitude of the response to implement based on the type of incident. A supervisor must also have the ability to oversee system operators.

Operations Center Director: This person holds the overall responsibility for the entire operation. This position requires a very competent engineer, one who is skilled not only in the technical issues related to ITS but also in management issues. This person does the planning, budgeting, and controlling for all fiscal matters related to the traffic operations center. The most important skills required by this position, however, are people skills. This person must manage, direct, inspire, and control a group of 15-20 highly skilled technicians.

Part-time support for database administration and configuration management is typically required to support ongoing O&M of the applications system. The database administrator will monitor and control the database. The configuration management position is required to manage system upgrades, control versions of both the applications and commercial-off-the-shelf (COTS) software, and to ensure that appropriate processes and procedures are followed and documentation maintained when upgrades or modifications are made to the system.

Most agencies that operate and maintain a traffic operations center have a minimal staff that can perform most of the functions noted above. On the other hand, the number of system operators is dependent on the size of the system, the complexity of the system, roles and responsibilities of the system operator, and the hours of operation. Many centers for arterial management systems do not have dedicated operators. Employees staff the center on an as-needed basis, especially for special events, large incidents, and emergencies.

Besides the personnel needed for the operations of the center, other personnel must be considered, such as the center manager, software support, communications support, and systems engineering support. These staff members also could have other part-time responsibilities depending on the needs of the traffic operations center.

Detailed guidelines on ITS operational staffing also are difficult to document. The most recent *FHWA Traffic Control Systems Handbook* provides some information. Additional information was available through a survey conducted for Florida Department of Transportation (FDOT). **Table 5-4** summarizes O&M staffing arrangements for selected ITS throughout the country as identified in these sources. The systems are all either freeway management systems or regional traffic management systems.

Table 5-4 – Traffic Management Systems O&M Staffing Summary

System (Source)	Pop.	Fwy Miles	Ramp Meters	CCTV	VMS	HOV	Ops Staff	Maint. Staff
Seattle (1)	516,000	100+	130	250	60	Yes	13	10
Minneapolis(2)	641,000	97	316	108	34	Yes	14	7
Detroit (2)	1,028,000	32	49	11	14	No	9	4
Chicago (2)	2,783,000	130	95	0	23	Yes	15	5
Long Island (2)	3,300,000	136	75	44	101	Yes	28	8
Atlanta (3)	2,000,000	75	5	59	45	Yes	8	72 (incl. Service patrols)
Maryland (3)	9,000,000	645	NO	21	35	Yes	3	23
Houston	4,000,000	160	NO	N/A	N/A	Yes	7	84 (incl. Service patrols)
San Antonio (3)	1,200,000	53	NO	89	100	Yes	7	24 (incl. ATIS)
Phoenix	3,100,000	174	114	120	58	Yes	22	21

Sources:
(1) Interview and response e-mail from Dave McCormick, WSDOT Northwest Region Traffic Engineer
(2) Traffic Control Systems Handbook, FHWA
(3) FDOT Survey/Research

The Maryland SHA operates CHART, a statewide freeway oriented ITS program, from a statewide traffic operations center and two satellite traffic operations centers. While the working pace during non-peak periods can be slow, SHA has implemented a policy that mandates no fewer than two system operators shall be on duty during any time at each center. Assuming two system operators a shift and three eight hour shifts a day, nine system operators are theoretically required to operate a traffic control center 24 hours a day, 365 days a year. This approach helps to maintain a core staff of sufficient size to cover all required seats on all shifts.

The Montgomery County Department of Transportation and Public Works in Maryland uses two system operators during the peak travel periods for its arterial management system, yet reduces the number to one during non-peak periods. The reduction is possible, in part, because their system is a local arterial-oriented system that is deployed primarily in one section of the County where substantial fluctuations occur in traffic flow and travel between the peak and non-peak travel periods. Other agencies report using similar staffing levels. The Colorado Department of Transportation (CDOT) uses three system operators over the course of 12 hours for a typical weekday.

The City of Bellevue operates an arterial management system, consisting of a centrally-controlled traffic signal system, CCTV cameras, and other ITS devices, for the major suburban city in the Puget Sound region of Washington. Bellevue's center is incorporated into the traffic engineering division's offices and is very readily accessible by the traffic engineering staff. The City of Bellevue actively manages their system, but does not have specific times of day that the center is routinely staffed. Traffic engineering personnel use the center to gather information for signal timing and to assess their timing plans after they are implemented. They staff the center when needed to help manage their system and

provide information to the public and other agencies. Some of the situations for which they staff the center include special events, the heavy holiday shopping season (there is a large retail mall in downtown Bellevue that generates substantial traffic), emergencies, and major incidents.

Even though some agencies operate their traffic operations center continuously, they may not have dedicated staff in the traffic operations center for the entire time. During off hours the functions of the traffic operations center may be transferred to an outside agency or to the police in a jointly operated center. In other cases, the functions of the system may be performed automatically with notice being given to an on-call traffic operations center operator or supervisor when unexpected events arise.

Staffing levels and hours of operations depend on many factors such as the size of the system, the functions performed, the number of field devices, and the desired service level. Staffing coverage should be determined by the responsible agency while developing the strategic management plan. Coverage needs should take into account the overall function of the traffic operations center, the tasks that will be conducted, and a variety of local conditions that may affect staffing coverage.

5.3.3 Hours of Operation

For systems that include a traffic operations center, one of the system requirements that needs to be identified is hours of operation. There are various operational modes under which a center can operate.

- **Full time, 24 hours per day, seven days per week**. Many freeway operations centers and regional traffic management centers are staffed at all times. Twenty-four hour operation is needed when significant events may occur within the geographical coverage of the center and resources are dispatched and coordinated from the center. The center also may respond by modifying traffic control schemes and disseminating information to the public and media.
- **Part time**. Many smaller freeway management systems and large arterial management systems have operators at specific, scheduled times. The schedules range from peak periods only (eight hours) to morning peak through afternoon peak (12 or 16 hours). These schedules are appropriate in large urban areas with a full time regional management center or when conditions only warrant part-time operations.
- **Opportunity based**. Many arterial traffic operations centers are staffed and utilized only when specific events or situations warrant; such as incidents or weather events. Staff also may utilize the center for special studies and to help them modify traffic control parameters.

5.3.4 National Experience

Table 5-5 presents a sample of how a traffic operations center may be staffed. This table is based on information contained in *ITE Traffic Control Systems Operation: Installation, Management, and Maintenance.* A level of service (LOS) categorization is used to define the different staffing needs of different levels of operation. This table provides insight for the reader on how staffing levels can grow as traffic conditions change and responsibilities increase. Note that the table indicates that only a single position is needed, over and above normal staffing, if the center is operated on an as-needed basis only.

Table 5-5 – Sample Staffing Levels

Agency Category	Level of Service	Program/ Center Manager	Shift Manager/ Supervisor	System Operator	Computer/ Network Support	Public Safety Liaison	Total
Small	Special Event, Incident Response	-	-	0.5	-	0.5	1
Medium	Peak Period Coverage (8 hrs/5 days)	0.5	1	1	0.5	1	4
Large	Short Weekday (12 hrs/5 days)	1	1	2	1	2	7
Extended Large	Long Weekday (16 hrs/5 days)	1	2	3	1	2	9
Regional	Continuous (24 hrs/7 days)	1	2	5	2	3	13

Source: ITE Traffic Control Systems Operation: Installation, Management, and Maintenance

5.3.5 Application to MAG Region

Staffing levels should support the needs and intent of the system. Adequate staffing accommodates all shifts without jeopardizing the individual staff member's mental and physical well being and their ability to perform the task at hand. A signal systems oriented traffic control center that is highly automated and typically addresses routine day-to-day functions could operate with a reduced staff. On the other hand, a traffic operations center with a need for interagency communications, information and data sharing on a 24-hour basis will be required to maintain a significantly greater number of staff.

Due to the varying degrees of ITS implementation and operations by each agency, there is not a simple answer to the hours of operation and staffing levels for a traffic operations center. Despite the shortage of staffing requirements, minimum staffing level guidelines for small, medium, and large cities for different levels of operations are presented herein. First, the categorical designations must be defined.

The categorical designations of small, medium, and large are based on the number of (1) general ITS equipment, (2) total traffic signals, (3) types of traffic signal control (i.e. closed loop/centralized system, emergency vehicle priority) and (4) traffic signal detection capabilities within each agency's control. Specific inventory descriptions are shown in **Figure 5-1**, which graphically depicts the totals for each agency and the category separators. ADOT is considered a regional operations center and was not included in this assessment.

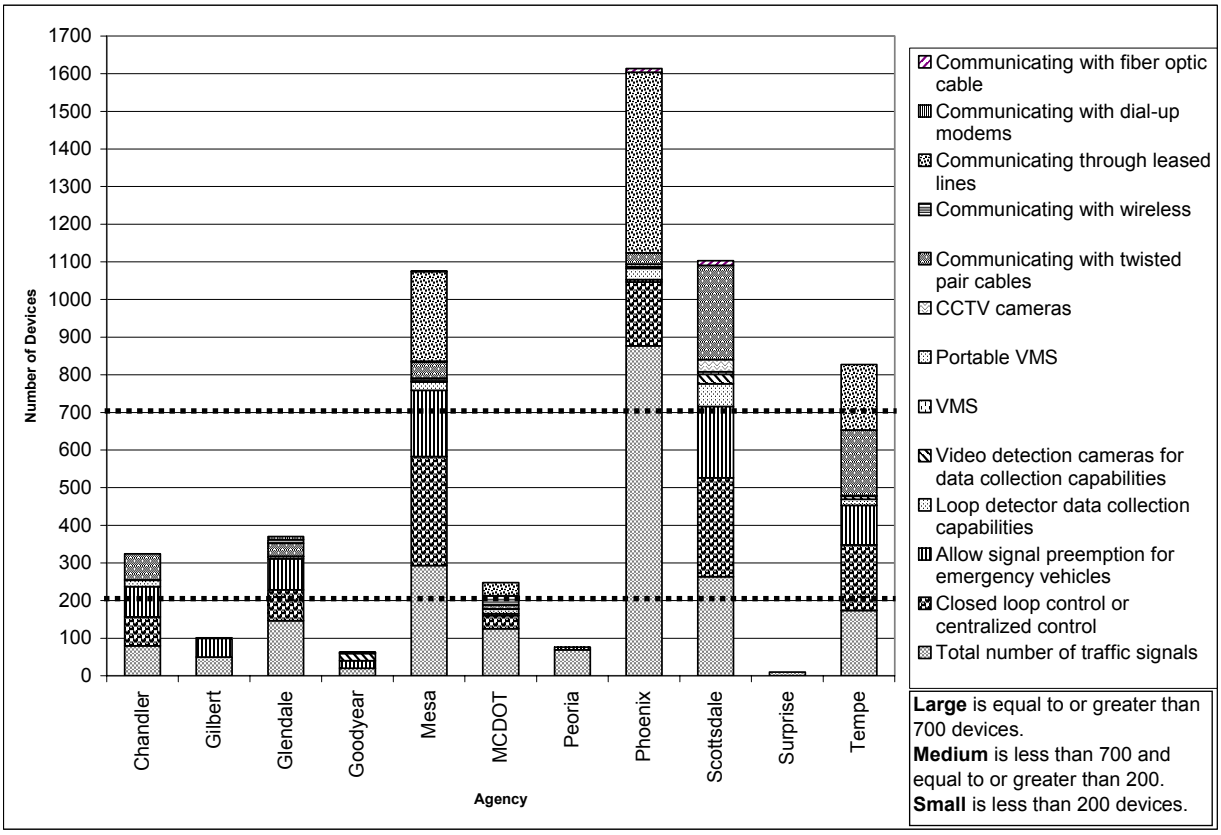

Figure 5-1 – Total Number of Existing Devices by Agency

As illustrated on **Figure 5-1**, the categories large, medium and small are separated in the following manner:

- Large agency – equal to or greater than 700 devices;
- Medium agency – less than 700 and equal to or greater than 200 devices; and
- Small agency – less than 200 devices.

5.3.6 Recommended Staffing Guidelines

Table 5-6 represents the possible staffing levels for regional, large, medium, and small agencies.

Table 5-6 – Possible Staffing Levels – Traffic Operations Center

Personnel	Regional	Large	Medium	Small
	Continuous (24 hrs/7 days)	Short Weekday (12 hrs/5 days)	Peak Period Coverage (8 hrs/5 days)	Special Event, Incident Response
Program/Center Manager	1	1	0.5	-
Shift Manager/Supervisor	4	1	1	-
System Operator	9	2	1	0.5
Software Programmer	2	1	0.5	-
Communications Technician	2	1	0.5	-
Technician	4	1	0.5	0.5
Public Safety Liaison	2	-	-	-
Administrative Support	2	-	-	-
IT Manager	**25**	-	-	-
Traffic Analysts	2	As needed	As needed	As needed
Total	**29**	**7**	**4**	**1**

Remaining consistent with the regional, large, medium, and small agency format, the following table represents the possible staffing levels for field maintenance personnel. It should be noted that ADOT, besides serving in a regional capacity, is a statewide agency; and the assumptions stated in this document for a regional agency do not include statewide operations.

Table 5-7 – Possible Staffing Levels – Field Maintenance Personnel

Personnel	Regional	Large	Medium	Small
Field Foreperson	1	2	1	-
Field Technician	1	2	1	0.5
Field Electronics Technician	4	6	2	1
Total	**6**	**10**	**4**	**1.5**

6. SAMPLE BUDGETS FOR OPERATIONS AND MAINTENANCE OF ITS

Some agencies estimate their budget for the management and operations of a traffic system using centerline miles or a percent of the constructed value. An alternate method considers anticipated staffing and equipment needs, which consists of two parts: personnel and physical plant. There are three major categories to consider for the O&M of a traffic system: traffic management center, preventive and response maintenance, and incident management response.

6.1 Sample Budgets to Support Various Levels of Operations and Maintenance

The subsequent tables (**Table 6-1** through **Table 6-4**) were developed based on studies conducted for the *BiState St. Louis Area Intelligent Vehicle Highway System Planning Study* and are illustrated in the *ITE Traffic Control Systems Operation: Installation, Management, and Maintenance*. Budgets estimates have been developed for regional centers, as well as for large, medium and small cities in the MAG region using actual data, estimated data, or data from the St. Louis tables that was adjusted for size and/or the current year.

Many agencies own the building that houses their traffic operations center; however, in the tables, building rental is used because it is easier to understand than the amortization of a building as an asset. Salaries and most unit costs are based on the St. Louis study information and have been increased from 1994 to 2002 dollars based on the Consumer Price Index (CPI) Conversion Factors.

All the budgets shown in this report are for stand-alone operations and do not include cross-jurisdictional operations. In other words, each agency is assumed to operate independently from the other agencies.

6.2 Traffic Management Center

Table 6-1 through **Table 6-4** illustrates sample budgets for traffic management centers. Costs for the traffic management center should include salaries, benefits, physical plant expenses, and utilities. Average annual salaries are dependent on the position and geographic area. The salaries in the following examples are based on 1994 salaries that have been modified using a cost of living adjustment. The benefits package cost for a typical government agency is assumed at 60 percent of the direct labor, which includes health and dental insurance, worker's compensation, Social Security, general liability, vacations, sick time, training and education, pensions, and union dues. The number of personnel is based on the possible staffing levels in **Table 5-6**.

Additional costs that should not be overlooked include physical plant expenses and utilities. Included in these costs are the building rent; heating, ventilation, and air conditioning (HVAC); electric utilities; building maintenance; and general supplies. For this example, the physical plant costs and quantities are general assumptions and have been adjusted based on relative size.

Table 6-1 – Traffic Operations Center – Regional

Personnel	Regular Shift Operations			Yearly Overtime Operations	
Title	Annual Salary (1)	Number of Personnel	Hourly Rate	Total Hours at 96 Hours/ Person	Overtime, Hourly Rate
Director	$ 56,000	1.0	$ 26.92	0	$ 40.38
Shift Supervisor/Manager	$ 47,400	4.0	$ 22.79	384	$ 34.18
System Operator	$ 30,400	9.0	$ 14.62	864	$ 21.92
Software Programmer	$ 46,200	2.0	$ 22.21	192	$ 33.32
Communications Specialist	$ 46,200	2.0	$ 22.21	192	$ 33.32
Traffic Analysts	$ 40,000	2.0	$ 19.23	192	$ 28.85
Technician, Control Center	$ 36,500	4.0	$ 17.55	384	$ 26.32
Administrative Assistant	$ 32,000	2.0	$ 15.38	192	$ 23.08
IT Manager	$ 50,000	1.0	$ 24.04	96	$ 36.06
Subtotal		27.0	$ 369.23	2400	NA
Annual Total, Unloaded			$ 768,000		$ 49,300
Benefits Package	60%		$ 460,800	0%	$ -
Annual Total			$ 1,228,800		$ 49,300
Total Personnel Operations Cost for a Year					**$ 1,278,100**

Notes:
a. Overtime operations are 12 holidays during the normal work year at 8 hours per person per holiday.
b. This table does not include the effects of vacations and sick time.
c. This table is for a 24-hour-operation control center.

Physical Plant Costs	Unit Costs (1)	Size or Quantity	Yearly Cost
Monthly Building Operating Costs (See Note 4)			
Building Maintenance			$ 112,904
Utilities			$ 70,449
Operating Supplies			$ 298,729
Operations Support			$ 280,750
EDP Support			$ 666,939
Software Licenses			$ 236,300
Training (out-of-state)			$ 14,329
Training (in-state)			$ 33,423
Other			
AZTech Support			$ 125,000
Total Physical Plant Operations Cost for a Year			**$ 1,838,823**

Notes:
1. All costs were in 1994 dollars, unless otherwise noted. All costs have been converted to 2002 dollars based on the Consumer Price Index (CPI).
2. CPI conversion factor = 1.217
3. Based on ITS Unit Cost Database (as of September 30, 2002)
4. Source: PECOS- ITI Data Models, Final Report. Annual Operation and Maintenance Forecast, Phoenix TOC. Arizona Department of Transportation. Report No. FHWA-AZ98-464

Source: ITE - Traffic Control System Operations

Table 6-2 – Traffic Operations Center – Large

Personnel	Regular Shift Operations			Yearly Overtime Operations	
Title	Annual Salary (1)	Number of Personnel	Hourly Rate	Total Hours at 96 Hours/ Person	Overtime, Hourly Rate
Director	$ 56,000	1.0	$ 26.92	0	$ 40.38
Shift Supervisor/Manager	$ 47,400	1.0	$ 22.79	96	$ 34.18
System Operator	$ 30,400	2.0	$ 14.62	192	$ 21.92
Software Programmer	$ 46,200	1.0	$ 22.21	0	$ 33.32
Communications Specialist	$ 46,200	1.0	$ 22.21	0	$ 33.32
Technician, Control Center	$ 36,500	1.0	$ 17.55	0	$ 26.32
Subtotal		7.0	$ 140.91	288	NA
Annual Total, Unloaded			$ 293,100		$ 7,500
Benefits Package	60%		$ 175,900	0%	$ -
Annual Total			$ 469,000		$ 7,500
Total Personnel Operations Cost for a Year					**$ 476,500**

Notes:
a. Overtime operations are 12 holidays during the normal work year at 8 hours per person per holiday.
b. This table does not include the effects of vacations and sick time.
c. This table is for a special event/incident response operation control center.
d. Personnel typically have other responsibilities in addition to these.

Physical Plant Costs	Unit Costs (1)		Size or Quantity		Yearly Cost
Monthly Building Operating Costs					
Rent (Yearly)	$ 12	/ft^2	1,100	ft^2	$ 13,400
HVAC & Electric (Daily)	$ 0.103	/kW	266.0	kW/day	$ 10,000
Maintenance	$ 946	/month	12	months	$ 11,400
General Supplies	$ 189	/month	12	months	$ 2,300
Communications, Telephone (General)					
Regular Phone Service	$ 405	/month	2	units	$ 11,300
Cellular Phones	$ 608	/month	2	units	$ 17,000
800 Number Service	$ 1,217	/month	1	number	$ 14,600
Communications, Modem Links					
Dial-up	$ 25	/drop/month (3)	12	locations	$ 3,500
Leased Lines	$ 122	/drop/month	23	agencies	$ 34,100
T-1 Lines (Video)	$ 700	/line/month (3)	1	agency	$ 700
Computers	**($ 189,000.00**	**Initial Cost)**			
Supplies	$ 572	/month	12	months	$ 6,900
Maintenance	10%	of initial cost/year	1	year	$ 18,900
Replacements	10%	of initial cost/year	1	year	$ 18,900
Miscellaneous					
Training	$ 500	/person	1	year	$ 3,500
Monthly Vehicle Costs	$ 0.61	/mile	1,944	mi/month	$ 14,200
Total Physical Plant Operations Cost for a Year					**$ 180,700**

Notes:
1. All costs were in 1994 dollars, unless otherwise noted. All costs have been converted to 2002 dollars based on the Consumer Price Index (CPI).
2. CPI conversion factor = 1.217
3. Based on ITS Unit Cost Database (as of September 30, 2002)
4. All costs are hypothetical and need to be determined for each location.

Table 6-3 – Traffic Operations Center – Medium

Personnel	Regular Shift Operations			Yearly Overtime Operations	
Title	Annual Salary (1)	Number of Personnel	Hourly Rate	Total Hours at 96 Hours/ Person	Overtime, Hourly Rate
Director	$ 56,000	0.5	$ 26.92	0	$ 40.38
Shift Supervisor/Manager	$ 47,400	1.0	$ 22.79	96	$ 34.18
System Operator	$ 30,400	1.0	$ 14.62	96	$ 21.92
Software Programmer	$ 46,200	0.5	$ 22.21	0	$ 33.32
Communications Specialist	$ 46,200	0.5	$ 22.21	0	$ 33.32
Technician, Control Center	$ 36,500	0.5	$ 17.55	0	$ 26.32
Subtotal		4.0	$ 81.85	192	NA
Annual Total, Unloaded			$ 170,300		$ 5,400
Benefits Package	60%		$ 102,200	0%	$ -
Annual Total			$ 272,500		$ 5,400
Total Personnel Operations Cost for a Year					**$ 277,900**

Notes:
a. Overtime operations are 12 holidays during the normal work year at 8 hours per person per holiday.
b. This table does not include the effects of vacations and sick time.
c. This table is for a special event/incident response operation control center.
d. Personnel typically have other responsibilities in addition to these.

Physical Plant Costs	Unit Costs (1)		Size or Quantity	Yearly Cost
Monthly Building Operating Costs				
Rent (Yearly)	$ 12	/ft^2	600 ft^2	$ 7,300
HVAC & Electric (Daily)	$ 0.103	/kW	152.0 kW/day	$ 5,700
Maintenance	$ 541	/month	12 months	$ 6,500
General Supplies	$ 108	/month	12 months	$ 1,300
Communications, Telephone (General)				
Regular Phone Service	$ 405	/month	1 units	$ 6,500
Cellular Phones	$ 608	/month	1 units	$ 9,700
800 Number Service	$ 1,217	/month	1 number	$ 14,600
Communications, Modem Links				
Dial-up	$ 25	/drop/month (3)	7 locations	$ 2,000
Leased Lines	$ 122	/drop/month	13 agencies	$ 19,500
T-1 Lines (Video)	$ 700	/line/month (3)	1 agency	$ 700
Computers	**($ 108,000.00**	**Initial Cost)**		
Supplies	$ 327	/month	12 months	$ 3,900
Maintenance	10%	of initial cost/year	1 year	$ 10,800
Replacements	10%	of initial cost/year	1 year	$ 10,800
Miscellaneous				
Training	$ 500	/person	1 year	$ 2,000
Monthly Vehicle Costs	$ 0.61	/mile	1,111 mi/month	$ 8,100
Total Physical Plant Operations Cost for a Year				**$ 109,400**

Notes:
1. All costs were in 1994 dollars, unless otherwise noted. All costs have been converted to 2002 dollars based on the Consumer Price Index (CPI).
2. CPI conversion factor = 1.217
3. Based on ITS Unit Cost Database (as of September 30, 2002)
4. All costs are hypothetical and need to be determined for each location.

Table 6-4 – Traffic Operations Center – Small

Personnel	Regular Shift Operations			Yearly Overtime Operations	
Title	Annual Salary (1)	Number of Personnel	Hourly Rate	Total Hours at 96 Hours/ Person	Overtime, Hourly Rate
Director	$ 56,000	0.0	$ 26.92	0	$ 40.38
Shift Supervisor/Manager	$ 47,400	0.0	$ 22.79	0	$ 34.18
System Operator	$ 30,400	0.5	$ 14.62	0	$ 21.92
Software Programmer	$ 46,200	0.0	$ 22.21	0	$ 33.32
Communications Specialist	$ 46,200	0.0	$ 22.21	0	$ 33.32
Technician, Control Center	$ 36,500	0.5	$ 17.55	0	$ 26.32
Subtotal		1.0	$ 16.08	0	NA
Annual Total, Unloaded			$ 33,500		$ -
Benefits Package	60%		$ 20,100	0%	$ -
Annual Total			$ 53,600		$ -
Total Personnel Operations Cost for a Year					**$ 53,600**

Notes:
a. Overtime operations are 12 holidays during the normal work year at 8 hours per person per holiday.
b. This table does not include the effects of vacations and sick time.
c. This table is for a special event/incident response operation control center.
d. Personnel typically have other responsibilities in addition to these.

Physical Plant Costs	Unit Costs (1)		Size or Quantity		Yearly Cost
Monthly Building Operating Costs					
Rent (Yearly)	$ 12	/ft^2	150	ft^2	$ 1,800
HVAC & Electric (Daily)	$ 0.103	/kW	38.0	kW/day	$ 1,400
Maintenance	$ 135	/month	12	months	$ 1,600
General Supplies	$ 27	/month	12	months	$ 300
Communications, Telephone (General)					
Regular Phone Service	$ 405	/month	1	units	$ 4,900
Cellular Phones	$ 608	/month	1	units	$ 7,300
800 Number Service	$ 1,217	/month	1	number	$ 14,600
Communications, Modem Links					
Dial-up	$ 25	/drop/month (3)	2	locations	$ 500
Leased Lines	$ 122	/drop/month	3	agencies	$ 4,900
T-1 Lines (Video)	$ 700	/line/month (3)	1	agency	$ 700
Computers	**($ 27,000.00**	**Initial Cost)**			
Supplies	$ 82	/month	12	months	$ 1,000
Maintenance	10%	of initial cost/year	1	year	$ 2,700
Replacements	10%	of initial cost/year	1	year	$ 2,700
Miscellaneous					
Training	$ 500	/person	1	year	$ 500
Monthly Vehicle Costs	$ 0.61	/mile	278	mi/month	$ 2,000
Total Physical Plant Operations Cost for a Year					**$ 46,900**

Notes:
1. All costs were in 1994 dollars, unless otherwise noted. All costs have been converted to 2002 dollars based on the Consumer Price Index (CPI).
2. CPI conversion factor = 1.217
3. Based on ITS Unit Cost Database (as of September 30, 2002)
4. All costs are hypothetical and need to be determined for each location.

6.3 Preventive and Response Maintenance

Preventive maintenance is a set of checks and procedures to be performed at regularly scheduled intervals to ensure reliable mechanical and electrical operation of the system equipment by reducing equipment failures, response maintenance, road user costs and liability exposure. The emphasis in preventive maintenance is on inspecting and cleaning all equipment for proper

operation, keeping maintenance records, and taking positive steps to repair or replace equipment based on the function and rated service life of each component.

Response maintenance is the initial response by an agency to any reported ITS subsystem or device malfunction. Response maintenance includes both field procedures used to restore device operation and shop procedures undertaken to repair and test the malfunctioning equipment.

Table 6-5 through **Table 6-8** shows sample field hardware maintenance budgets. The number of personnel is based on the possible staffing levels for field maintenance personnel shown in **Table 5-7**.

Table 6-5 – Field Hardware – Regional Center

Personnel	Regular Shift Operations (8 Hours/Day)			5% Overtime Operations	
Title	Hourly Rate	Number of Personnel	Hourly Cost	Number of Personnel	Hourly Cost
Field Foreperson	$ 21.06	1	$ 21.06	1	$ 31.59
Field Technician	$ 16.37	1	$ 16.37	1	$ 24.56
Field Electronics Technician	$ 20.47	4	$ 81.90	4	$ 122.85
	$ -		$ -	0	$ -
	$ -		$ -	0	$ -
	$ -		$ -	0	$ -
Subtotal (Hourly)			$ 119.33		$ 179.00
Subtotal (Yearly)			$ 248,200		$ 18,600
Benefits Package	60%		$ 148,900	0%	$ -
Subtotals			$ 397,100		$ 18,600
Total Personnel Operations Cost for a Year					**$ 415,700**

Notes:
a. Overtime operations are 12 holidays during the normal work year at 8 hours per person per holiday.
b. This table does not include the effects of vacations and sick time.
c. This table is for a 16-hour-operation control center.

Physical Plant Costs	Unit Costs		Size or Quantity	Yearly Cost
Electric Power				
Electric (Daily)	$ 0.103	/kW	1,231 kW/day	$ 46,400
CCTV/Sign HVAC (Daily)	$ 0.103	/kW	199 kW/day	$ 7,500
Vehicle Costs and Equipment, Initial			Yearly Factor = 7.0	
High Bucket, 65 ft.	$ 67,000	/purchase	1 (8 yr life span)	$ 9,600
Bucket/Van	$ 43,000	/purchase	2 (8 yr life span)	$ 12,400
Equipment/Splicing Van	$ 49,000	/purchase	1 (8 yr life span)	$ 7,000
Vehicle Costs, Monthly Operations				
High Bucket, 65 ft.	$ 0.61	/mile	867 mi/month	$ 6,300
Bucket/Van	$ 0.61	/mile	867 mi/month	$ 12,700
Equipment/Splicing Van	$ 0.61	/mile	867 mi/month	$ 6,300
Hardware Maintenance/Supplies				
All Field Equipment	$ 132,000	/month	12 months	$ 1,584,000
Total Physical Plant Operations Cost for a Year				**$ 1,692,200**

Notes:
1. All costs were in 1994 dollars, unless otherwise noted. All costs have been converted to 2002 dollars based on the Consumer Price Index (CPI).
2. CPI conversion factor = 1.217
3. Based on ITS Unit Cost Database (as of September 30, 2002)
4. All costs are hypothetical and need to be determined for each location.

Table 6-6 – Field Hardware – Large Center

Personnel	Regular Shift Operations (8 Hours/Day)			5% Overtime Operations	
Title	Hourly Rate	Number of Personnel	Hourly Cost	Number of Personnel	Hourly Cost
Field Foreperson	$ 21.06	2	$ 42.12	2	$ 63.18
Field Technician	$ 16.37	2	$ 32.75	2	$ 49.12
Field Electronics Technician	$ 20.47	6	$ 122.85	6	$ 184.27
Subtotal (Hourly)			$ 197.71		$ 296.57
Subtotal (Yearly)			$ 411,200		$ 30,800
Benefits Package	60%		$ 246,700	0%	$ -
Subtotals			$ 657,900		$ 30,800
Total Personnel Operations Cost for a Year					**$ 688,700**

Notes:
a. Overtime operations are 12 holidays during the normal work year at 8 hours per person per holiday.
b. This table does not include the effects of vacations and sick time.
c. This table is for a special event/incident response operation control center.
d. Personnel typically have other responsibilities in addition to these.

Physical Plant Costs	Unit Costs		Size or Quantity	Yearly Cost
Electric Power				
Electric (Daily)	$ 0.103	/kW	663 kW/day	$ 25,000
CCTV/Sign HVAC (Daily)	$ 0.103	/kW	107 kW/day	$ 4,100
Vehicle Costs and Equipment, Initial			Yearly Factor = 7.0	
High Bucket, 65 ft.	$ 67,000	/purchase	1 (8 yr life span)	$ 9,600
Bucket/Van	$ 43,000	/purchase	2 (8 yr life span)	$ 12,400
Equipment/Splicing Van	$ 49,000	/purchase	1 (8 yr life span)	$ 7,000
Vehicle Costs, Monthly Operations				
High Bucket, 65 ft.	$ 0.61	/mile	600 mi/month	$ 4,400
Bucket/Van	$ 0.61	/mile	600 mi/month	$ 8,800
Equipment/Splicing Van	$ 0.61	/mile	600 mi/month	$ 4,400
Hardware Maintenance/Supplies				
All Field Equipment	$ 91,000	/month	12 months	$ 1,092,000
Total Physical Plant Operations Cost for a Year				**$ 1,167,700**

Notes:
1. All costs were in 1994 dollars, unless otherwise noted. All costs have been converted to 2002 dollars based on the Consumer Price Index (CPI).
2. CPI conversion factor = 1.217
3. Based on ITS Unit Cost Database (as of September 30, 2002)
4. All costs are hypothetical and need to be determined for each location.

Table 6-7 – Field Hardware – Medium Size Center

Personnel	Regular Shift Operations (8 Hours/Day)			5% Overtime Operations	
Title	Hourly Rate	Number of Personnel	Hourly Cost	Number of Personnel	Hourly Cost
Field Foreperson	$ 21.06	1	$ 21.06	1	$ 31.59
Field Technician	$ 16.37	1	$ 16.37	1	$ 24.56
Field Electronics Technician	$ 20.47	2	$ 40.95	2	$ 61.42
Subtotal (Hourly)			$ 78.38		$ 117.57
Subtotal (Yearly)			$ 163,000		$ 12,200
Benefits Package	60%		$ 97,800	0%	$ -
Subtotals			$ 260,800		$ 12,200
Total Personnel Operations Cost for a Year					**$ 273,000**

Notes:
a. Overtime operations are 12 holidays during the normal work year at 8 hours per person per holiday.
b. This table does not include the effects of vacations and sick time.
c. This table is for a special event/incident response operation control center.
d. Personnel typically have other responsibilities in addition to these.

Physical Plant Costs	Unit Costs		Size or Quantity	Yearly Cost
Electric Power				
Electric (Daily)	$ 0.103	/kW	409 kW/day	$ 15,400
CCTV/Sign HVAC (Daily)	$ 0.103	/kW	66 kW/day	$ 2,500
Vehicle Costs and Equipment, Initial			Yearly Factor = 7.0	
High Bucket, 65 ft.	$ 67,000	/purchase	1 (8 yr life span)	$ 9,600
Bucket/Van	$ 43,000	/purchase	0 (8 yr life span)	$ -
Equipment/Splicing Van	$ 49,000	/purchase	1 (8 yr life span)	$ 7,000
Vehicle Costs, Monthly Operations				
High Bucket, 65 ft.	$ 0.61	/mile	288 mi/month	$ 2,100
Bucket/Van	$ 0.61	/mile	288 mi/month	$ -
Equipment/Splicing Van	$ 0.61	/mile	288 mi/month	$ 2,100
Hardware Maintenance/Supplies				
All Field Equipment	$ 44,000	/month	12 months	$ 528,000
Total Physical Plant Operations Cost for a Year				**$ 566,700**

Notes:
1. All costs were in 1994 dollars, unless otherwise noted. All costs have been converted to 2002 dollars based on the Consumer Price Index (CPI).
2. CPI conversion factor = 1.217
3. Based on ITS Unit Cost Database (as of September 30, 2002)
4. All costs are hypothetical and need to be determined for each location.

Table 6-8 – Field Hardware – Small Size Center

Personnel	Regular Shift Operations (8 Hours/Day)			5% Overtime Operations	
Title	Hourly Rate	Number of Personnel	Hourly Cost	Number of Personnel	Hourly Cost
Field Foreperson	$ 21.06	0	$ -	0	$ -
Field Technician	$ 16.37	0.5	$ 8.19	0.5	$ 12.28
Field Electronics Technician	$ 20.47	1	$ 20.47	1	$ 30.71
Subtotal (Hourly)			$ 28.66		$ 42.99
Subtotal (Yearly)			$ 59,600		$ 4,500
Benefits Package	60%		$ 35,800	0%	$ -
Subtotals			$ 95,400		$ 4,500
Total Personnel Operations Cost for a Year					**$ 99,900**

Notes:
a. Overtime operations are 12 holidays during the normal work year at 8 hours per person per holiday.
b. This table does not include the effects of vacations and sick time.
c. This table is for a special event/incident response operation control center.
d. Personnel typically have other responsibilities in addition to these.

Physical Plant Costs	Unit Costs		Size or Quantity	Yearly Cost
Electric Power				
Electric (Daily)	$ 0.103	/kW	127.80 kW/day	$ 4,800
CCTV/Sign HVAC (Daily)	$ 0.103	/kW	20.70 kW/day	$ 800
Vehicle Costs and Equipment, Initial			Yearly Factor = 7.0	
High Bucket, 65 ft.	$ 67,000	/purchase	1 (8 yr life span)	$ 9,600
Bucket/Van	$ 43,000	/purchase	0 (8 yr life span)	$ -
Equipment/Splicing Van	$ 49,000	/purchase	0 (8 yr life span)	$ -
Vehicle Costs, Monthly Operations				
High Bucket, 65 ft.	$ 0.61	/mile	90 mi/month	$ 700
Bucket/Van	$ 0.61	/mile	90 mi/month	$ -
Equipment/Splicing Van	$ 0.61	/mile	90 mi/month	$ -
Hardware Maintenance/Supplies				
All Field Equipment	$ 14,000	/month	12 months	$ 168,000
Total Physical Plant Operations Cost for a Year				**$ 183,900**

Notes:
1. All costs were in 1994 dollars, unless otherwise noted. All costs have been converted to 2002 dollars based on the Consumer Price Index (CPI).
2. CPI conversion factor = 1.217
3. Based on ITS Unit Cost Database (as of September 30, 2002)
4. All costs are hypothetical and need to be determined for each location.

6.4 Incident Management Response

The purpose of incident/emergency management is to assist with traffic management by setting up emergency lane/road closures, installing and maintaining signed detour routes and providing directional information to motorists. The Arizona Local Emergency Response Team (ALERT) provides incident/emergency management on Phoenix metropolitan area freeways. The Regional Emergency Action Coordinating Team (REACT) is a pilot project that currently provides incident/emergency management on arterial roadways to a few local agencies within the MAG region.

The sample budget shown in **Table 6-9** represents typical incident/emergency management response costs for both personnel and the physical plant based 24-hour operations based on one team.

Table 6-9 – Incident Management Response

Personnel	Regular Shift Operations (8 Hours/Day)			5% Overtime Operations	
Title	Hourly Rate	Number of Personnel	Hourly Cost	Number of Personnel	Hourly Cost
Shift Supervisor/Manager	$ 22.81	3	$ 68.43	3	$ 102.65
Field Foreperson	$ 21.06	5	$ 105.29	5	$ 157.94
Highway Technician (Hourly)	$ 17.54	12	$ 210.51	12	$ 315.77
State Police*	$ -		$ -	0	$ -
HAZMAT*	$ -		$ -	0	$ -
Medical*	$ -		$ -	0	$ -
Fire*	$ -		$ -	0	$ -
Towing*	$ -		$ -	0	$ -
Subtotal (Hourly)			$ 384.23		$ 576.35
Subtotal (Yearly)			$ 799,200		$ 59,900
Benefits Package	60%		$ 479,500	0%	$ -
Subtotals			$ 1,278,700		$ 59,900
Total Personnel Operations Cost for a Year					**$ 1,338,600**

Notes:
* Most agencies that operate TMC's are not responsible for covering these personnel costs, but the services are listed here as a reminder that they are part of the cost to the overall community.

Physical Plant Costs	Unit Costs		Size or Quantity	Yearly Cost
Communications				
Cellular Phones	$ 608	/month	4 Units	$ 29,200
Vehicle Costs, Initial			Yearly Factor = 7.0	
Dump Truck/ Impact Attenuator	$ 49,000	/purchase	0 (8 yr life span)	$ -
Pickup Truck with Arrow	$ 43,000	/purchase	5 (8 yr life span)	$ 30,700
Vehicle Costs, Monthly Operations				
Dump Truck/ Impact Attenuator	$ 0.61	/mile	500 mi/month	$ -
Pickup Truck with Arrow	$ 0.61	/mile	500 mi/month	$ 18,200
Total Physical Plant Operations Cost for a Year				**$ 78,100**

Notes:
1. All costs were in 1994 dollars, unless otherwise noted. All costs have been converted to 2002 dollars based on the Consumer Price Index (CPI).
2. CPI conversion factor = 1.217
3. Based on ITS Unit Cost Database (as of September 30, 2002)
4. All costs are hypothetical and need to be determined for each location.

Source: ITE - Traffic Control System Operations

For the MAG region, it is assumed that four incident/emergency management response teams will be needed; one regional team (ADOT) and three teams to generally consist of the west, central and east teams. It is likely that the west, central, and east teams will cross jurisdictional boundaries similar to fire department mutual aid operations; therefore, each large, medium and small agency will share three incident/emergency management response teams. The following table illustrates the percentage share of the incident/emergency management response teams between large, medium and small agencies.

Table 6-10 presents a possible cost sharing arrangement for a region-wide arterial incident management program. As shown in **Table 6-10**, the small, medium, and large cities each share a proportionate share of the operating and capital costs of the program.

The calculations for **Table 6-10** assume that 4 large cities, 3 medium cities, and 13 small cities will contribute to the arterial incident management program. It is proposed that the large cities share 40% of the costs of a single team, while the medium and small cities each share 25% and 5% of the costs of a single arterial incident management team, respectively. This will provide enough resources for 3 regional arterial incident management teams. As an example, the total personnel costs for an arterial incident management team is $1,338,600. A large city (e.g. Phoenix) would be asked to contribute 40% of the personnel costs of one team, or a total of $535,440. This is demonstrated in **Table 6-11**.

Table 6-10 – Incident/Emergency Management Response Cost Sharing

Category	Number of Agencies	Share of Cost (1 team)	Agencies * % Cost
Large	4	40%	1.6
Medium	3	25%	.75
Small	13	5%	.65
Total Number of Arterial Incident Management Teams			**3**

6.5 Sample Budget Summary

Table 6-11 contains a summary of the sample budgets for regional, large, medium and small city operations centers.

Table 6-11 – Budget Estimate Summary

	Traffic Management Center		Maintenance of Field Hardware		Incident Management Response Team		Total
	Personnel	Physical Plant	Personnel	Physical Plant	Personnel	Physical Plant	
Regional	$ 1,278,100	$ 1,838,823	$ 415,700	$ 1,692,200	$ 1,338,600	$ 85,400	$ 6,648,823
Large	$ 476,500	$ 180,700	$ 688,700	$ 1,167,700	$ 535,440	$ 34,160	$ 3,083,200
Medium	$ 277,900	$ 109,400	$ 273,000	$ 566,700	$ 334,650	$ 21,350	$ 1,583,000
Small	$ 53,600	$ 46,900	$ 183,900	$ 66,900	$ 66,930	$ 4,270	$ 422,500

Table 6-12 presents the proposed categorical designation of each agency in the MAG region and the recommended hours of operation for each agency's traffic operations center. Using the information contained in **Table 6-11** and **Table 6-12** provides each city in the MAG region with a cost estimate of operating and maintaining a traffic operations center and the associate field equipment.

Table 6-12 – Agency Categorical Designations

Agency	Area Designation	Hours of Operation
ADOT	Regional	Continuous (24/7)
Apache Junction	Small	
Avondale	Small	
Buckeye	Small	
Carefree	Small	
Cave Creek	Small	
Chandler	Medium	8 hour
El Mirage	Small	
Fountain Hills	Small	
Gila Bend	Small	
Gila River Indian Community	Small	
Gilbert	Small	Special Events/ Incident Response
Glendale	Medium	8 hour
Goodyear	Small	Special Events/ Incident Response
Guadalupe	Small	
Litchfield Park	Small	
Mesa	Large	12 hour
MCDOT	Medium	8 hour
Paradise Valley	Small	
Peoria	Small	Special Events/ Incident Response
Phoenix	Large	12 hour
Queen Creek	Small	
Salt River Pima-Maricopa Indian Community	Small	
Scottsdale	Large	12 hour
Surprise	Small	Special Events/ Incident Response
Tempe	Large	12 hour
Tolleson	Small	
Wickenburg	Small	
Youngtown	Small	

7. ALTERNATIVE STAFFING APPROACHES FOR OPERATIONS AND MAINTENANCE OF ITS

There are three approaches that can be followed to provide O&M support for ITS systems – in-house, outsourcing, and facilities management. Each has its own distinct benefits and risks associated with it. Agencies should identify and select a course of action best suited to its needs, culture, and existing situation.

7.1 In-House Staffing

From an operations perspective, using a staff comprised of all agency employees is ideal because managers and team leaders have a single personnel management system to deal with and team cohesiveness is easier to establish and maintain. But given today's trends of downsizing and doing more with less, many agencies around the country have a difficult time in finding, training, and keeping the required talented staff to operate and maintain their ITS.

One approach to building an in-house O&M staff is to use the resources of other maintenance, construction inspection, safety or engineering staff whose work is seasonally oriented, or requires "fair weather" to complete. This could include staff from other agencies in the same region. Talented, capable staff may be available within an organization if a flexible certification, training, and refresher program is provided and maintained. This approach also enhances the organization as well as the individual. **Table 7-1** illustrates some of the benefits from in-house support.

Table 7-1 – In-House Support Benefits and Risks

In-House Benefits	Risks
Establish a high-tech career track within the agency.	Recruiting and retaining technology staff is difficult, with private firms offering high salaries to personnel with similar qualifications.
Share staff with other departments with similar needs.	Traditionally difficult to control costs and maintain quality standards, for the reasons cited above.
Sense of ownership and understanding of the system.	Competing priorities within the City government make it difficult over the long term to maintain the commitment.

Maintaining the skills necessary to support the fast-changing technologies is a problem with utilizing in-house support. In-house support can be supplemented by outsourcing, where required.

7.2 Outsourcing

It is becoming increasingly difficult for public agencies to fill highly technical positions that usually require special classifications and a high pay scale. Personnel departments within the public sector tend to resist creating special classifications and typically follow a policy of setting pay scales by the number of persons supervised. Positions requiring highly specialized skills often do not supervise many people, if any at all, making it difficult to justify the pay scales necessary to attract qualified staff.

In an era of government downsizing, state and local agencies often face pressures to cut staffing and freeze existing vacancies. Leaving vacancies unfilled in traffic signal and ITS positions will usually result in significantly reduced system effectiveness.

Outsourcing can often by-pass these problems. Staffing through outsourcing does not result in more staff counted on the agency's payroll. The budgetary item for outsourcing is often treated by the agency administration like a line item for electricity to run the equipment, with none of the negative perceptions involved in financing new staff positions. It also is easier for a private firm to fill vacancies with appropriately skilled personnel as well as remove poorly performing employees.

While outsourcing offers solutions to the types of staffing problems noted above, it is not without its own set of problems. Some of the problems with outsourcing include the necessity of continuing tight administration of performance under the contract, potential higher turnover rates in contractor personnel than in-house staff, scarcity of private sector personnel with adequate traffic experience, and friction with in-house staff.

Outsourcing requires careful development of a detailed, clearly defined set of contractor requirements, including task descriptions, schedules, performance standards, and payment terms. The INFORM system on Long Island uses separate outsourcing contracts for computer hardware, loop detector assemblies, VMS, and communications. In addition, outsourcing normally:

- Obligates the contractor to commit to a certain number of hours for a lump sum fee, or for an unlimited number of hours for a set rate per hour;
- Specifies exactly what tasks the contractor will perform and what tasks the Owner will perform;
- Requires little or no contractor investment; and
- Specifies performance standards and accomplishment criteria for detailed tasks.

Outsourcing has been a mainstay in the service industry for decades, and, therefore, many contract models are available for public agencies to utilize. **Table 7-2** illustrates some benefits and risks resulting from outsourcing O&M responsibilities.

Table 7-2 – Outsourcing Benefits and Risks

Outsourcing Benefits	Risks
Clear separation between agency and contractor responsibilities.	Little flexibility to get services outside the specific scope without extensive administration and additional cost.
Agency can decide what tasks it wishes for the contractor to perform with its own forces.	Little incentive for the contractor to exceed performance standards of accomplishment criteria.

7.3 Facilities Management

The third option is for agencies to engage a facilities management contractor in a public-private venture for the purposes of providing ITS O&M. While facilities management shares some characteristics with outsourcing, also it provides a level of flexibility and incentives for both parties that a service contract does not.

Facilities management, or facilities outsourcing, involves use of private-sector staff to perform traditional government services, working on a broad mission basis, and targeting the standard of mission accomplishment. Although facilities management is a new concept in traffic management, it is a tried and true method for providing service in other high-technology

environments, including computer facilities, law enforcement dispatching systems and telecommunications systems.

Facilities management is different than outsourcing, where the private contractor is required to follow the explicit directions of the government manager. With outsourcing, there is little incentive for the private contractor to control costs, because it is paid by the person-hour employed. Under facilities management, the private-sector firm and the public agency have congruent goals and the same incentive to succeed. Because it is paid for mission fulfillment, the private-sector contractor has the incentive to seek efficiencies and cost-effective techniques for achieving the contract objectives. **Table 7-3** summarizes potential benefits and risks associated with facilities management.

Table 7-3 – Facilities Management Benefits and Risks

Facilities Management Benefits	Risks
Keep up with technical realities.	All public/private ventures have risks if incentives are not carefully crafted.
Keep up with business realities.	Control and liability concerns.
Provides common goals and the same incentive to succeed for all parties involved.	

7.4 Applicability to MAG Region

A sound estimate that addresses the agency's strengths and weaknesses should be developed prior to each agency determining the appropriate alternative for staffing O&M. Liabilities and risks also should be considered in selecting the best course.

Agencies should consider an appropriate method to obtain the necessary staff to provide support for O&M and to supplement agency staff. In general, software and hardware maintenance, traffic signal re-lamping, VMS and communication maintenance, and system administration lend themselves to outsourcing.

Fiber optic system maintenance has been successfully staffed through outsourcing by many other agencies. In the MAG region, each agency could contract out all aspects of maintaining their fiber system, or provide front line assessment with existing staff and have a company under contract to repair the system when agency staff cannot. WSDOT maintains their cable in this way. In addition, their contract has a provision to allow the Department to direct the contractor to install fiber. The Department uses this contract to extend their cable short distances when a traditional construction contract would take too long to develop and require too much overhead for the limited amount of fiber to be installed.

8. STAFF TRAINING

The *MAG ITS Strategic Plan Update, Technical Memorandum No. 9, Training and Capacity Building Plan* (August 2000), contains an overview of the process of identifying short- and long-term professional capacity building needs to support continued ITS deployment and operations in the MAG region.

Adequately trained staff is critical to the successful operation of any traffic system. The first step in determining the training needs and whether staff is adequately trained is to define the knowledge, skills, and abilities that are needed for each staff position within an organization. A training plan or program should then be developed to identify training opportunities to provide employees with the needed knowledge, skills, and abilities. The program or plan should focus on gaps between minimum requirements for the position and the requirements to perform in the position at an optimal level. Individual staff members should know the optimal knowledge, skills, and abilities for his or her position. Supervisors should include a review of optimal knowledge, skills, and abilities with the employee during periodic performance reviews and identify areas where training is needed to bring the employee up to the optimal level.

8.1 National Experience

Many agencies have training plans (sometimes referred to as training matrices) in place. The plans or matrices are usually developed and maintained in the Human Resources section of the organization. Some organizations include a formal training program to provide needed skills to their employees.

Commonly, the training programs are geared toward general knowledge, skills, and abilities needed for employees to progress through the organization. Management training is often a focus. State Departments of Transportation include specific technical training for the mainstream positions within the department, such as highway design and construction and roadway maintenance. Some organizations have expanded these programs to include specialty areas, such as ITS.

WSDOT maintains training matrices for each classification in the organization. Training is offered in management, technical/professional, maintenance and safety, employee development, and information technology. The training matrix identifies the training that is available for each classification. Supervisors and employees identify the training needed during the performance review process. WSDOT offers training courses for traffic signal operations, but few offer courses for ITS. WSDOT sponsors courses offered by the National Highway Institute and other Federal organizations as a way to expand training opportunities.

The Northwest Region of WSDOT developed a structured training program for system operators and other operations staff. Some of the training that is offered includes:

- Operating all parts of the system;
- Learning basic traffic theory;
- Operating software routines;
- Learning specific operational procedures;
- Attending freeway core classes (e.g., highway design, construction methods, communication skills, human factors considerations in freeway design);

- Operating field equipment; and
- Trouble-shooting problems in the system.

Much of this training is provided through a formalized on-the-job-training program for system operators. Center managers have established a specific sequence of reading operations documentation and performing supervised system operation to provide new operators with the knowledge and skills to operate the system independently. For formal training courses offered by the Department, WSDOT allows employees to enroll over the Department's intranet.

WSDOT's Northwest Region also identified a comprehensive program for training traffic signal and ITS maintenance staff. The program is titled, "Plan of Instruction for Traffic Systems Technicians." The plan identifies functions for signal and electrical technicians by level within the classifications. The comprehensive program identifies duties, sub-tasks needed to perform the duties, steps within each sub-task, the type of performance for each step, and the difficulty in learning each step.

ODOT's Statewide ITS Maintenance Plan identifies training gaps for maintaining ITS. It also identifies five different training concepts as possibilities for addressing training gaps:

- Contractual training, where training is included as a part of device procurement;
- Remedial training, which is provided by the vendor under a separate contract after the device has been deployed;
- Development training, which is provided by colleges or technical schools and may provide theoretical understanding that that may be applicable to multiple devices;
- Training from other agencies, which involves taking advantage of contractual training received at other transportation agencies when they receive a new device deployment; and
- Internal training, where senior ODOT maintenance technicians train junior technicians on maintenance activities.

The ODOT plan identifies what type of training covers the areas of training needed by ODOT maintenance personnel, the characteristics of the type of training, and the advantages and disadvantages of each type.

The Federal Highway Administration's ITS Joint Program Office developed a professional capacity building (PCB) program for ITS professionals. The USDOT published a set of reports under the title, "Building Professional Capacity in ITS" that identified needs for training and education in the ITS field, identified the skills or core competencies needed by classifications within a given type of agency, and identified specific training and education courses for each classification identified. (These reports are available on-line at the FHWA's electronic document library, http://www.its.dot.gov/welcome.htm.) The program looked at a variety of organizational needs, including those from local agencies. The *MAG ITS Strategic Plan Update* used this program as a model/reference.

For each competency recommendation, a specific course, or set of courses, were recommended. USDOT developed many of these courses and offer them through the National Highway Institute. The report identified other courses as being general training and education courses or courses that have yet to be developed.

8.2 Resources

It would be very difficult, if not impossible, for a single agency to develop and offer the complete set of ITS training courses that are necessary for employees who maintain and operate traffic signals and ITS. Even to fund all of the needed training opportunities available would be a major financial burden; however, there are many resources that exist that can provide training opportunities at lower costs.

- Training courses offered by professional organizations during their regular meetings. The Institute of Transportation Engineers, Transportation Research Board, and Intelligent Transportation Society of America, among others, offer training courses, some of which are offered in conjunction with their regular meetings. These organizations provide a rich resource for staff training.
- Training courses developed and offered by USDOT. The USDOT, principally through the National Highway Institute, develops and offers a host of ITS training courses. A description and other information about these courses can be found at http://pcb.volpe.dot.gov/. Many of the courses discussed in the "Building Professional Capacity in ITS" documents are described in this website and offered by the USDOT. Agencies also could contact the FHWA Division Office in Phoenix or the FHWA Western Resource Center in San Francisco.
- Training courses sponsored by ADOT. State Departments of Transportation often offer their training courses to local agencies. They also often sponsor courses offered by the USDOT. Agencies could take advantage of these courses through their contacts in ADOT.
- Training courses offered by other agencies in the MAG region. Other agencies in the MAG region also may offer or sponsor ITS training courses. The agency could establish contacts in those other agencies to find out about training opportunities they may offer.
- Training courses offered at local vocational and community colleges. Many of the more general skills and educational needs identified in the USDOT's Professional Capacity Building documents can be addressed through established educational institutions.
- Utilize the experience within the agency's organization. Each agency has employees with valuable experience in maintaining or operating ITS. The agency could formalize a program to pass this information on to entry and junior level employees, much as WSDOT does for system operations.

9. WORKS CITED

1. Regional Transportation Operations Collaboration and Coordination. A Primer for Working Together to Improve Transportation Safety, Reliability and Security. USDOT, FHWA. November 2002.